POWER

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To Win the Job—

HONESTLY, between ourselves, if you were managing a power plant where the engine room was a source of pride to you as its chief; where the equipment was not only highly efficient but looked it—and

You advertised for an engineer—and

You lined up eight or ten applicants—and

You ran your eye over the line—

WHAT WOULD BE YOUR FIRST IMPRESSION?

Why, the type of engineer pictured above would look good to you when contrasted with the careless-looking man in the next column—you'd think his appearance an index of his probable carelessness in the engine room.

The first impression has many times turned away the better of two good engineers.

No man need be a tailor's dummy to be neatly and plainly dressed.

No man need look like an animated hunk of oily waste; running a steam plant is often dirty work, but it earns clean money.

Because a man has to clean boiler tubes once a month he need not go about looking like a chimney sweep.

Clean overalls stay clean in a clean engine room.

Behold the salesman in all his glory! Would he ever get by the office boy if his appearance did not typify the product he is trying to sell?

No! He looks the part. He looks like good goods. He *is* the goods at the startoff!

The ethics of good engineering business contains this clause:

Be clean; be neat; look just as bright and snappy outwardly as your mentality is inwardly.

You Must Look the Part!

City Sewage Flushing Plant

By Warren O. Rogers

An ordinary marine propeller is used for sewage-flushing purposes.

The propeller is driven by a 400-horsepower induction motor, and has a capacity of 500 cubic feet of water per minute. The plant is operated by the city of New York.

There has recently been put into operation a novel method of pumping sewage water by the city of New York. This plant is located at the foot of Douglas street, Brooklyn, and is used to flush the Gowanus canal. Originally the condition of the water in the canal was not bad, but the increased population and manufacturing industries have made this water at present most foul.

At one time it was supposed that the tide would clear the canal of all impurities, and storm water sewers were run into the head of the canal through which a large amount of surface water was drained from the streets of the city

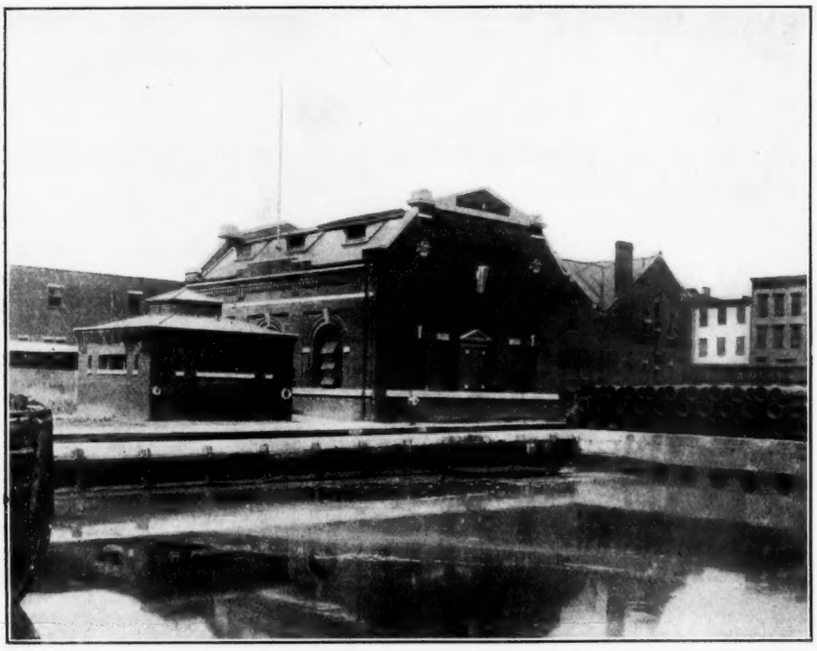


FIG. 1. GOWANUS CANAL AND NEW CITY PUMPING PLANT

of Brooklyn. But this arrangement failed to come up to the expectation of those who advanced this idea. As far back as 1880, the city engineers were engaged in solving the problem of bettering the unsanitary conditions of the canal.

During recent years the condition of the water has been so filthy and foul, and a demand for a final solution so great, that the city engineers finally devised a plan for doing the work by flushing the water from the dead end of the canal into the East river, where it will be swept away by the tides.

In Fig. 1 is shown an exterior view of the pumping plant. The building is set back from the street, covers a plot 67x63 feet and is fronted by a green lawn and gatehouse. The building is constructed of red brick with a concrete floor, with green glazed brick around the lower portion of the wall for the inside.

A steel circular motor pit has been built 24 feet deep and 29 feet in diameter. The plates are ½ inch at the top and ¾ inch in thickness at the bottom and are set on a concrete foundation 5 feet thick. This concrete foundation rests on sheet-steel piling which reaches down to a depth of 10 feet.

In this motor pit is a 400-horsepower induction motor which receives three-phase alternating current at 550 volts; it is shown in Fig. 2. The motor runs at 120 revolutions per minute, full load, and is connected by means of an 8-inch shaft to a 9-foot propeller, which has four adjustable blades with a pitch of 5 feet 6 inches. The shaft runs through a water-cooled thrust bearing placed between the motor and the stuffing box in the partition between the motor pit and the wheel pit. The shaft is supported in the tunnel by two lignum-vitæ bearings. The tunnel has an opening 50 feet wide at the canal and is 12 feet deep, but it narrows down to 9 feet at the wheel, allowing for ⅛-inch clearance, and then diverges to 12 feet in diameter beyond the propeller. The propeller is 56½ feet distant from the motor. It has a capacity of 30,000 cubic feet per minute. The water is delivered into Buttermilk channel through a sewer 6300 feet long. The water handled by this propeller weighs approximately 64 pounds per cubic foot. The motor is reversible, so that in case the propeller becomes fouled it can be reversed and made to free itself. The blades are also reversible, and the flow of water can be reversed should it ever become necessary.

The speed of the motor is controlled by a drum-type, rheostatic hand con-

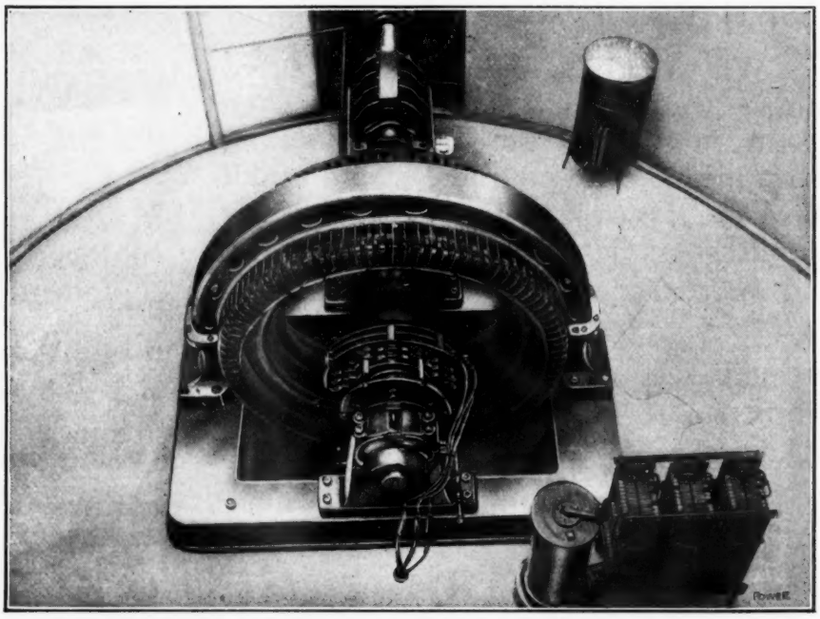


FIG. 2. FOUR HUNDRED-HORSEPOWER INDUCTION MOTOR IN MOTOR PIT

troller placed beside the motor in the motor pit.

The tunnel on each side of the propeller is provided with two 14-foot gate valves which are motor-operated and are raised and lowered by means of vertical screw stems. These gates permit emptying the tunnel section between them if it becomes necessary to get at the propeller wheel. To do this a separate motor-driven pump is used to pump out the sump into which the water in this section of the tunnel is emptied. A plan of the flushing arrangement is shown in Fig. 3.

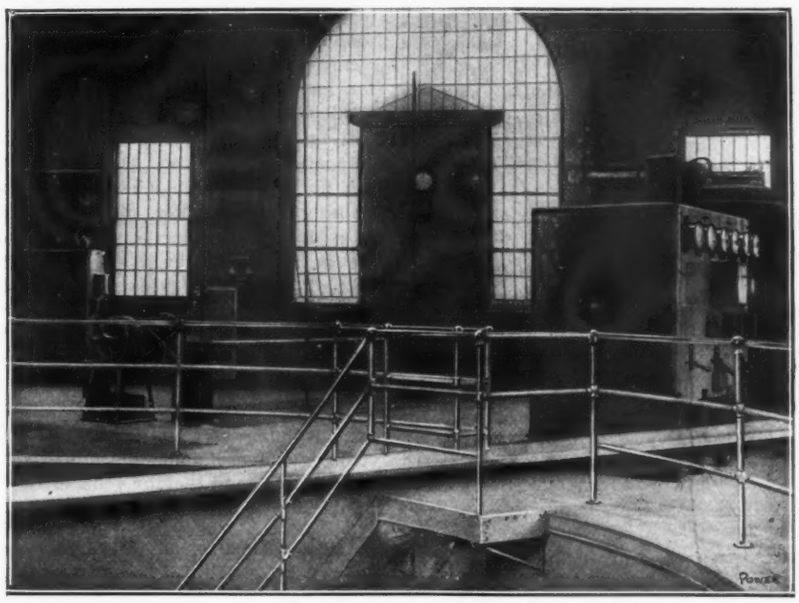


FIG. 4. MAIN FLOOR OF THE PUMPING PLANT

On the main floor of the building are located three oil-cooled transformers (Fig. 4), which transform the electrical energy from 6600 to 550 volts for uses on all of the motors. There is also a main switchboard on which are mounted the power-factor meters, the frequency meters, two ammeters, two voltmeters and one recording wattmeter. There is also a separate switchboard for operating the 10½-horsepower motors which operate the gates, and one for controlling the vertical centrifugal 12-horsepower pump motor which is connected to the sump. As in most other of the city plants, Edison current is used, and there are two switchboards for controlling the incoming electrical energy, one for the central station, the other for the plant.

This flushing plant was first operated on June 9, for three hours. Beginning June 21, the plant was run for 108 hours and observations indicated that the propeller could be relied upon to change the water content of the entire length of the canal in eight hours. With the wheel working at its normal speed, a current toward the head of the canal of 4 inches per second was created at a point one mile away from the intake. The channel bed, however, is so foul from the accumulated wastes of many years that it will probably take several months' pumping before conditions reach a satisfactory state.

The work of designing and building the Gowanus flushing tunnel and pumping plant has been carried out by the bureau of sewers of the borough of Brooklyn, under the direction of E. J. Fort, chief engineer.

Philippine Coal for Home Use

The Philippine Islands are commencing to produce a considerable portion of their own coal supply, according to United States Consul-General G. E. Anderson, at Hongkong.

At East Batan the mine is turning out 100 tons daily and when its new chute system is completed it is expected that 100,000 tons a year will be the output.

Over 400,000 tons were imported in the fiscal year ending June 30, 1911. Up to 1909, Australia supplied most of the coal used, but during the last two years, owing to labor troubles in the former country, Japan has furnished nearly one-half of the total imports.

Aided by the government of the Philippines in its advancing funds against contracts for coal, it is believed that the entire local output will be taken by the government or by local consumers. for the next year or more, and there will be no necessity of importing coal.

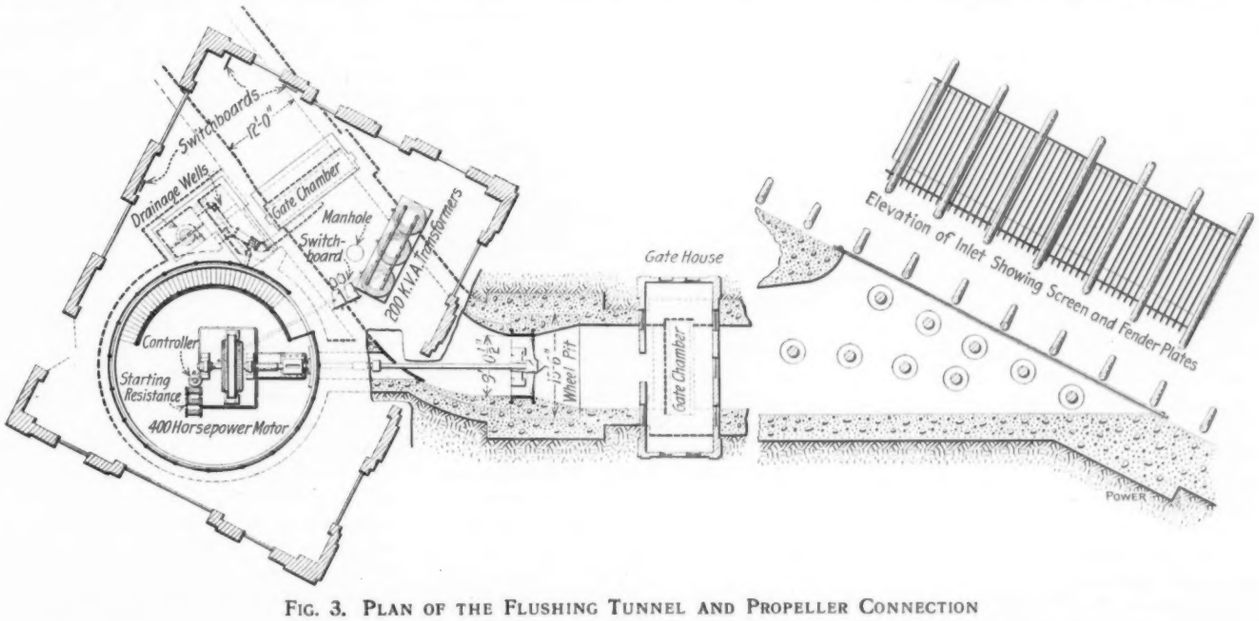


FIG. 3. PLAN OF THE FLUSHING TUNNEL AND PROPELLER CONNECTION

The Fusing Temperature of Coal Ash*

By E. G. Bailey

The main factor in the formation of clinker is the difference between the fusing temperature of the ash and the temperature to which it is subjected.

Any factor, such as excess air, rate of combustion and thickness of fuel bed, which will affect this temperature, may cause a corresponding change in the amount and nature of the clinker from any given coal.

*Read before the Ohio Society of Mechanical, Electrical and Steam Engineers, at Canton, November 17-18.

Factors Governing Rate of Combustion

The rate of combustion depends primarily upon the rate of air supply to the heated surface of the fuel in the furnace. The difference in draft pressure across the fuel bed is generally considered to be a measure of the rate of combustion. This, however, is true only when other conditions, such as the resistance of the fuel bed to the flow of air, surface of fuel exposed, etc., are the same. Any difference in the condition of the fuel bed, such as its thickness, closeness with which it packs or cokes together, the accumulation of ash or the formation of clinker, will cause a change in its resistance by changing the length of the restricted passages through it or by reducing the available area for the flow of air and thereby affecting its flow for any given drop in draft pressure across it. Sometimes a thin vitreous clinker will form over the entire grate so that no air can pass through the fuel bed, and combustion ceases, even though there may be a difference of a half inch or more of draft between the ashpit and the furnace.

The thickness and condition of the fuel bed govern the area of fuel exposed to the air passing through it and thereby affect the rate of combustion as well as the relative excess or deficiency of air supply.

All coal contains more or less ash, some of which was in the original vegetable matter from which the coal was formed; other ash resulted from the deposit of mud or silt in the water in which this vegetable matter was submerged, while a third source is from the water which filters through the coal seams as it passes from the surface to the subterranean streams and springs. This water is charged with lime, iron, etc., some of which is retained in the coal seams and appears as ash when the coal is burned. Ash usually contains alumina, silica, lime, magnesia, soda, potash, iron, phosphorus and sulphur, but the relative amounts of each vary widely in different coals. In general, the ash resembles clay, but it varies more in its composition and characteristics than do the clays used in making red building brick as compared with that used in making good firebrick.

The ash from different coals varies widely in its fusing temperature, some melting at a temperature as low as 2000 degrees Fahrenheit while other ash requires more than 3000 degrees Fahrenheit to fuse it. Clinker is nothing but melted ash, and ash having a low fusing temperature will form clinker much more readily than will an ash of a high fusing temperature when subjected to the same fuel-bed conditions.

Seldom all the ash, even though having a low fusing temperature, is melted into a clinker in a boiler furnace. One reason for this is that all parts of the fuel bed are not hot enough to melt the ash. Another reason is that the composition of the ash in different parts of the seam, and therefore in different lumps of coal, may vary so that some of it melts readily while the other has a fusing temperature well above that of the fuel bed. In actual tests it has been found that the percentage of ash which is formed into clinker as well as the obstructed grate area per pound of clinker holds a close relation to the fusing temperature of the ash from different coals when burned under similar conditions.

Formation of Clinker Dependent upon Fusing Temperature of Ash

If there is a variation in the conditions, such as fuel-bed temperature, method of handling the ash, etc., different amounts of clinker will be formed from the same coal. The real measure of clinker formation is the difference between the fusing temperature of the ash and the temperature to which this ash is subjected. If an ash which melts at 2100 degrees is subjected to an actual temperature of 2500 degrees, the ash will not only be melted, but it will become very fluid and contain a considerable quantity of heat above its solidifying temperature and, like overheated iron, will run quite a distance against the incoming cold air before it hardens into a clinker. Under these conditions it is likely to form a very thin clinker and obstruct a considerable portion of grate area. On the other hand, if ash requiring 2450 degrees to fuse it is subjected to this temperature of 2500 degrees, some clinker will be formed, but it will be a smaller proportion of the total ash and will be of the open, porous kind which quickly cools as it gets into a cooler zone; it will also have less detrimental effect in obstructing the passage for air and reducing the rate of combustion.

It is well known that a fireman who bars and stirs his fire so as to lift the ash up into the fuel bed, is only augmenting the formation of clinkers, and he is doing just what he should not do; that is, subjecting the ash to the hottest part of the fuel bed instead of leaving it as near the grates as possible, where it will keep cool until it can be worked through the grates into the pit or until the fire is cleaned. The admission of steam under the grates or merely the presence of water in the ashpit has a cooling tendency upon the lower part of the fuel bed, and thereby reduces clinker trouble.

Results of Tests

Two 24-hour boiler tests made on three vertical fire-tube boilers for the purpose of determining the relative commercial value of two similar coals, show some very interesting data regarding the relation between the fusing temperature of ash, clinkers, rate of combustion and boiler efficiency. All conditions were maintained as nearly the same as possible on the two tests, and great care was taken in regard to the weights of coal and water, coal and ash samples, flue-gas analyses, draft readings, etc.

The data bearing upon clinkers and rate of combustion are given in Table 1. The ash and heat value of the two coals were practically identical on the dry basis, and while there was a slight difference in the character of the two coals as indicated by the volatile matter, the principal difference was in the fusing temperature of the ash, this being 2750 degrees Fahrenheit for *A* and 2390 for *B*. The same two firemen fired during both tests, and they were equally familiar with the two coals.

On test No. 1 with coal *A*, all fires had been cleaned three hours before starting the run, and no further cleaning was done except during the twenty-first and twenty-second hours of the test, when all the fires were cleaned. The fire was sliced six times during the test and no clinkers were taken out except when cleaning.

On test No. 2, with coal *B*, considerable trouble was encountered on account of the formation of clinkers. The fires were sliced 11 times, and even though all the fires had been cleaned three hours before the beginning of the test, it became necessary to pull out some clinkers during the sixth, twelfth and eigh-

teenth hours of the test, and all fires were thoroughly cleaned during the twentieth and twenty-first hours of the test. There was difficulty at times in maintaining the desired steam pressure, which on the average was 5 pounds lower than with coal *A*. The draft for coal *A* was 0.22 inch, while for coal *B* it was 0.26 inch, and about 4 per cent. less horsepower was developed.

TABLE 1. RESULTS OF TWO 24-HOUR TESTS

Number of boilers	3	
Type of boilers	Vertical fire tube	
Total grate surface, square feet	83.0	
Hight of furnaces, inches	38.5	
Water-heating surface, square feet	3367	
Superheating surface, square feet	1347	
Type of grates	stationary	
Air space in grates, per cent	50	
Width of air space, inch	½	
Test number	1	2
Duration of test, hours	24	24
Steam pressure by gage, pounds	102.0	97.2
Draft between damper and boilers, inches of water	0.22	0.26
Draft in fireboxes, inches of water	0.14	0.16
Temperature of flue gases, leaving boiler, degrees Fahrenheit	574	581
Coal used	*A*	*B*
Size of coal	run-of-mine	
Analysis of coal:		
Moisture, per cent	2.74	4.11
Volatile, per cent	16.96	21.82
Fixed carbon, per cent	74.50	68.38
Ash, per cent	5.80	5.69
Sulphur, per cent	0.71	1.27
Dry basis, ash	5.96	5.93
Dry basis, B.t.u	14,802	14,806
Fusing temperature of ash, degrees Fahrenheit	2,750	2,390
Weight of coal burned, pounds	24,974	24,603
Weight of ash and refuse from grate, pounds	804	1365
Weight of ash and refuse from pit, pounds	1101	824
Total weight of ash and refuse, pounds	1905	2189
Total weight of clinker, hand-picked from grate refuse, pounds	294	746
Percentage of ash and refuse to coal	7.63	8.90
Percentage of clinker to coal burned	1.18	3.03
Percentage of clinker to ash in coal burned	20.2	53.3
Projected area per pound of clinker, square feet	0.076	0.106
Calculated total grate area obstructed by clinker, square feet	22	79
Percentage of combustible in total refuse	24.31	35
Coal burned per square foot of grate per hour, pounds	12.5	12.4
Boiler horsepower developed	279.4	268.1
Percentage of rated horsepower developed	90.2	86.5
Flue gas analysis:		
Carbon dioxide, per cent	10.78	10.05
Oxygen, per cent	8.12	8.97
Carbon monoxide, per ct.	1.08	0.88
Nitrogen, per cent	80.02	80.10
Air excess, per cent	63.5	75.0
Heat balance:		
Heat used in evaporation, per cent	62.4	61.7
Loss due to latent heat	2.9	2.8
Loss due to products of combustion	10.8	10.2
Loss due to air excess	6.0	6.6
Loss due to CO	5.1	4.3
Loss due to combustible in refuse	1.9	3.1
Loss due to radiation and unaccounted for (difference)	10.9	11.3
	100.0	100.0

All of the difference between the action of the two coals is traceable directly to the formation of clinkers. With coal *A* 804 pounds of refuse were cleaned from the grate, a large portion of which was slate and such impurities, and 1101 pounds were taken from the pit. With coal *B* the conditions were nearly reversed, 1365 pounds being taken from the grate and 824 pounds from the pit. All clinker larger than about 1 inch was picked out of the refuse from off the grate and weighed. This amounted to 294 pounds for coal *A* and 746 for coal *B*. However, in both cases considerable clinker had been broken into small pieces during the cleaning and handling so that these results do not represent the total weight of ash which was fused to a clinker, but the results are comparable. The clinker picked out was 20.2 per cent.

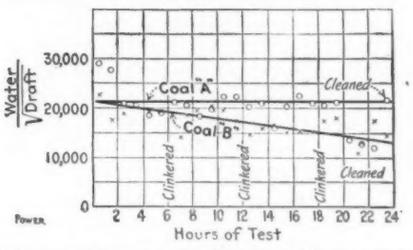


FIG. 1. EFFECT OF CLINKER FORMATION UPON EVAPORATION WITH COALS A AND B

of the weight of ash contained in the amount of coal *A* which was burned, and 53.3 per cent. of the ash in coal *B*.

Still further data were obtained relative to the thickness and area obstructed by the different clinkers. A large number of clinkers of various sizes were laid on paper and the projected outline of each was drawn. From these areas and the weight of each individual clinker, the projected area per pound of clinker was determined, and was found to be 0.076 square foot in the case of coal *A*,

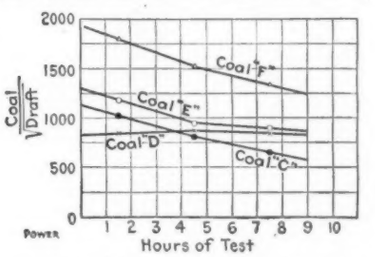


FIG. 2. RESULTS WITH DIFFERENT COALS AT OHIO STATE UNIVERSITY

and 0.106 square foot for coal *B*. This means that the clinker from coal *B* was so much thinner that the same weight would obstruct about one-third more grate area than that from coal *A*. Multiplying these values by the weight of clinkers from the respective coals gives respectively 22 and 79 square feet of obstructed area if all of the clinker were on the grate at the end of 24 hours. The clinker, however, is accumulative and the effect of it can best be studied by referring to Fig. 1, which is plotted from Table 2. In this table the factor computed by dividing the weight of water fed to the boilers each hour by the square root of the average draft for the same period, is equivalent to the weight of water evaporated per hour with 1 inch of draft, assuming that the rate of evaporation varies as the square root of the draft for any given fuel-bed condition.

From the plotted results of coal *A*, it is seen that the rate of evaporation per unit draft is substantially uniform throughout the test. In other words, the accumulation of refuse on the grate causes so slight an increase in the fuel-bed resistance as compared with the resistance of the fuel bed itself that practically no more draft was required at the end of a 24-hour run than at the beginning. On the other hand, coal *B* shows

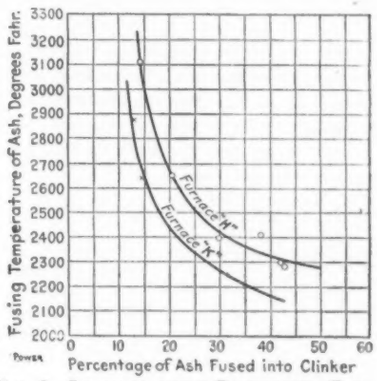


FIG. 3. RESULTS WITH DIFFERENT FURNACES

a decided decrease in the rate of evaporation per unit draft as the clinker accumulates. The effect of taking out some clinkers during the sixth, twelfth and eighteenth hours is noticed by the increased rate of evaporation per unit draft. The effect of the thorough cleaning near the end of each test is apparent in causing a reduction in the rate of combustion while the fires are being burned down, cleaned and brought back into condition.

CONCLUSIONS

The conclusions to be drawn from these tests are that more clinker of a much more troublesome nature results from the coal with the ash of lower fusing temperature, and if a limited draft is available so that all of it is required to evaporate the desired amount of water when the grates are clean, coal *A* would carry the load satisfactorily when cleaning the fires only once in 24 hours, while coal *B* under the same conditions drops off 25 per cent. in the evaporation in 18 hours, even though two partial cleanings have been made in the meantime. Hence the plant with limited draft must give due consideration to the clinkering properties of the coal used.

TESTS AT OHIO STATE UNIVERSITY

Table 3 gives data from several boiler tests made by Professor Hitchcock at Ohio State University. Most of these tests were of 10 hours' duration, starting with a fire which had been cleaned one hour before the beginning of the test and again during the forepart of the tenth hour of the test. In the cases of

coals *C* and *D*, the draft used in calculating the factors was that measured between the boiler and the damper, while the firebox draft was used in the others. Coals *C* and *D* were burned on a plain grate with 50 per cent. air space under a dutch oven, while coals *E* and *F* were burned on shaking grates under a firebrick arch with a special horizontal return-tubular boiler setting.

When burning coal *C* there was a decrease of about 20 per cent. in the rate of combustion during each of the second and third three-hour periods as compared with the one preceding, which was due to the formation of a thin, vitreous clinker.

Coal *D* showed considerable variation in the rate of combustion per unit draft in the different periods of the various tests. This may be due in part to the peculiar coking action of this coal which caused it to vary greatly in the resistance of the fuel bed itself. The average, however, shows practically the same rate of combustion during each of the three periods. This coal formed a fragile, porous clinker which evidently offered very little additional resistance to the flow of air through the fuel bed.

With coal *E* a thin clinker which obstructed about 0.21 square foot per pound was formed and had a decided influence in decreasing the rate of combustion. The difference between the second and third periods was not so great as between the first and second. This may have been due to the greater use of the shaking grates during the latter part of the tests.

Coal *F* had a higher ash-fusing temperature than coal *E*, yet there was nearly three times as much ash in the same weight of coal, and, being a free-burning noncoking coal, it burned at a higher rate with the same draft and therefore so formed clinker that the rate of combustion during the third period was 75 per cent. of that during the first, or about the same as coal *E*. Comparing the second test of coal *F* with the first, it is noted that the average rate of combustion was nearly twice as much, the percentage of ash fused to clinker was more than doubled, while the rate of combustion decreased nearly three times as fast as on the first test with this coal. The clinker formed from this coal covered 0.13 square foot of grate per pound of clinker.

The relative rates of combustion during the three periods of the tests of coals *C*, *D*, *E* and *F* are plotted in Fig. 2.

From a careful study of the various individual tests of Table 3, it is noted that there is an indication that the percentage of ash fused to clinker increases with a decrease in the air excess, which means an increase in the fuel-bed temperature. Also from the tests of coal *C* there appears to be a decrease in the percentage of ash fused to clinker as the intensity of the draft is increased. It is plausible that the stronger draft and the higher velocity of air causes the lower part of the fuel bed to be enough cooler to prevent the formation of so much clinker, although it has previously been assumed that the higher the rate of combustion the higher the furnace temperature and therefore the greater the amount of clinker formed.

The fact that the different conditions under which the same coal may be burned will cause different percentages of its heating value to be utilized in evaporating water, does not argue against the B.t.u. being considered in the purchase of coal, nor does the variation in the factors affecting the formation of clinker interfere with the fusing temperature of the ash being used in connection with the purchase of coal, so that some certainty and uniformity may be assured in the all-important factor of its clinkering property.

Results with Different Furnaces

As a further evidence of the relation between the fusing temperature of ash and the formation of clinker, reference is made to Fig. 3, in which are plotted the results of several tests on different furnaces, several coals of various fusing temperatures being tested in each furnace. In these tests, like those previously described, all clinker larger than about 1 inch was picked out of the refuse and its percentage to the total ash in the coal burned was determined. The general conditions prevailing in these furnaces during the tests were as follows:

Furnace	*H*	*K*
Average coal burned per square foot of grate per hour, pounds	22	11
Average draft in firebox, inches of water	0.12	0.39
Average air excess, per cent	80	135

The conditions in furnace *H* during these tests were more as they should be, while furnace *K* had a much stronger draft than was needed and the excess air was correspondingly high. On account of the higher rate of combustion and the lower excess air, furnace *H* was much hotter than furnace *K* and as a result of this, more clinker was made from ash of the same fusing temperature than in furnace *K*.

One of the most striking points brought out by these curves is that the percentage of ash fused to clinker increases very rapidly as the fusing temperature of the ash falls below 2500 degrees Fahrenheit. Another important factor is that with a lower fusing temperature of the ash the character of the clinker changes, so that much more grate surface is covered per pound of clinker.

Formation of Clinkers with Mechanical Stokers

In the case of mechanical stokers the clinker trouble varies with the type of stoker. Some make more clinker from

TABLE 2. SHOWING EFFECT OF ACCUMULATIVE CLINKER

	Test No. 1. Coal A				Test No. 2. Coal B			
Hour of Test	Water Fed to Boilers, Pounds	Draft in Flue by Recorder, Inches	Percentage of Time Damper Was Wide Open	Water / $\sqrt{\text{Draft}}$	Water Fed to Boilers, Pounds	Draft in Flue by Recorder, Inches	Percentage of Time Damper Was Wide Open	Water / $\sqrt{\text{Draft}}$
1	7,730	0.07	0	29,200	11,995	0.28	100	22,600
2	8,808	0.10	0	27,800	8,868	0.26	100	17,500
3	8,109	0.15	0	21,000	10,075	0.28	89	18,900
4	8,468	0.17	0	20,600	10,853	0.28	79	20,200
5	9,220	0.29	53	18,500	10,382	0.29	99	19,200
6	8,299	0.19	13	19,000	5,518	0.08	4	19,400
7	9,102	0.18	0	21,200	7,346	0.29	91	13,700
8	9,749	0.23	76	20,400	9,951	0.28	100	18,600
9	8,566	0.22	44	18,300	10,669	0.29	100	19,700
10	10,768	0.30	100	19,700	10,853	0.28	91	20,500
11	12,016	0.29	79	22,300	10,578	0.29	100	19,600
12	12,368	0.30	90	22,400	9,207	0.28	100	17,300
13	10,878	0.29	94	20,200	8,881	0.37	100	14,700
14	10,500	0.25	58	21,000	8,737	0.30	100	16,000
15	5,965	0.14	13	16,000	9,077	0.30	100	16,600
16	9,991	0.24	75	20,400	8,306	0.30	100	15,200
17	11,067	0.24	68	22,500	8,437	0.29	79	15,500
18	9,834	0.22	56	21,000	7,953	0.28	89	15,100
19	9,677	0.22	60	20,600	8,815	0.25	58	17,600
20	10,114	0.23	73	21,100	8,535	0.22	0	18,200
21	6,547	0.23	63	13,700	4,035	0.17	0	9,800
22	6,207	0.24	33	12,700	5,958	0.20	4	13,400
23	4,966	0.17	28	12,000	8,378	0.23	19	17,500
24	10,369	0.23	58	21,600	6,223	0.18	0	14,700
Average	9,139	0.216	47	20,100	8,735	0.261	71	17,100

the same coal than would be formed in a hand-fired furnace, while in others the ash is continually being taken from the furnace before troublesome clinkers are formed. Ash of a very low fusing temperature will give some trouble on almost any kind of stoker, either by bridging over the dump grate, sticking to and clogging the moving bars, or by cutting off the inflow of air through the grate and thereby allowing the grate to become hot and burned. As a rule, the detrimental effect of clinkers on mechanical stokers is not to gradually decrease the rate of combustion per unit draft, but results in the extra labor of cleaning fires, cost of stoker repairs, or sometimes by stopping the stoker.

Effect of Sulphur

There is a prevalent opinion that high sulphur in coal is the cause of clinker trouble. While there may be cases where a coal high in sulphur will make a more troublesome clinker than another coal with a lower percentage of sulphur, yet the sulphur usually has very little to do with it. Some of the sulphur in coal usually exists in combination with iron as pyrite, and in some cases the iron tends to act as a flux to the remaining ash and causes a reduction of the fusing temperature of the mixture. Much the greater part of the sulphur burns and leaves the furnace in the form of a gas. From all the data accumulated so far, there appears to be no relation whatever between the sulphur in the coal and the amount or nature of clinker formed, nor is there any relation between the sulphur and the fusing temperature of the ash.

Many users of gas coal have deter-

TABLE 3. RESULTS OF TESTS AT OHIO STATE UNIVERSITY

Coal	Test	Coal Fired per Hour Divided by $\sqrt{\text{Draft}}$ 1st 3 Hours	2d 3 Hours	3d 3 Hours	Ratio of 2d to 1st	3d to 1st	Percentage of Ash Fused to Clinker	Pounds of Coal Burned per Square Foot of Grate per Hour	Draft Leaving Boiler, Inches Water	Thickness of Fire, Inches	Air Excess, Per Cent.
Coal *C*. Ash, 7.12 per cent. Fusion temperature, 2300 degrees Fahrenheit.	1	1105	785	513	0.71	0.46	34	24	0.30	8	78
	2	1167	945	793	0.81	0.68	29	25	0.30	10	62
	3	1103	866	607	0.78	0.55	24	24	0.30	6	77
	4	800	708	624	0.89	0.78	12	19	0.30	4	127
	5	1180	754	462	0.64	0.39	42	17	0.20	8	72
	6	973	817	688	0.84	0.71	34	27	0.40	8	81
	7	960	863	755	0.90	0.79	25	29	0.51	8	88
	8	957	777	676	0.81	0.71	35	21	0.29	8	79
	9	1007	745	692	0.74	0.69	22	28	0.51	6	95
	Average..	1028	807	646	78.5	63.0					
Coal *D*. Ash, 8.55 per cent. Fusion temperature, 2640 degrees Fahrenheit.	1	608	595	615	98	101	3	17	0.31	4	187
	2	1125	1020	815	91	72	17	25	0.32	8	90
	3	910	925	1130	102	124	14	31	0.30	12	67
	4	782	758	705	97	90	28	32	0.50	10	112
	5	800	930	958	116	120	18	28	0.30	10	78
	6	895	950	798	106	89	21	27	0.32	12	84
	7	650	866	728	133	112	19	18	0.18	9	89
	8	1070	1100	1260	103	118	27	20	0.15	9	76
	9	740	768	768	104	104	18	36	0.81	14	80
	Average..	842	879	864	104	102					
Coal *E*. Ash, 4.16 per cent. Fusion temperature, 2210 degrees Fahrenheit.	1	1360	1177	1140	86.5	83.8	58	16.3	0.20	6	42
	2	1310	1173	1085	89.5	82.9	51	16.2	0.19	8	43
	3	1075	916	916	85.2	85.2	50	15.7	0.31	7	74
	4	1125	857	693	76.0	61.5	67	15.9	0.18	11	54
	5	1145	867	970	75.7	84.6	47	15.9	0.17	8	78
	6	1122	746	654	66.5	58.3	64	14.9	0.18	7	41
	Average..	1189	956	909	80.4	76.4					
Coal *F*. Ash, 12.15 per cent. Fusion temperature, 2550 degrees Fahrenheit.	1	1813	1593	1357	87.9	74.7	30	24.9	0.21	6	68
	2	2310	1160	735	50.2	31.8	68	46.6	0.46	12	25

TABLE 4. MISCELLANEOUS RESULTS SHOWING EFFECT OF FUSING TEMPERATURE, ASH, SULPHUR AND IRON

No.	Character of Coal	Fusing Temperature of Ash, Degrees Fahrenheit	Ash in Coal, Per Cent.	Sulphur in Coal, Per Cent.	Iron Oxide in Ash, Per Cent.
1	Anthracite	3150	14.85	0.76	.....
2	Semibituminous	3070	14.81	1.36	.....
3	Semibituminous	2910	7.97	0.96	7.0
4	Semibituminous	2880	7.33	0.70	10.0
5	Semibituminous	2830	13.85	1.78	.....
6	Bituminous	2750	10.60	0.60	.....
7	Semibituminous	2750	5.80	0.71	.....
8	Semibituminous	2710	7.84	0.96	7.90
9	Semibituminous	2680	10.61	1.00	.....
10	Semibituminous	2640	8.90	1.25	12.0
11	Gas	2640	9.84	0.72	6.6
12	Semibituminous	2610	8.93	2.14	.....
13	Semibituminous	2610	8.61	1.29	.....
14	Semibituminous	2550	12.85	3.10	23.7
15	Gas	2520	7.22	1.22	13.0
16	Anthracite	2520	10.08	0.61	6.1
17	Bituminous	2510	8.02	1.12	.....
18	Semibituminous	2480	4.97	0.76	.....
19	Gas	2460	6.91	2.35	24.7
20	Coke	2460	9.51	0.80	.....
21	Bituminous	2450	7.26	0.84	.....
22	Semibituminous	2440	8.68	3.42	.....
23	Bituminous	2360	9.30	2.29	.....
24	Semibituminous	2320	13.06	0.92	7.1
25	Gas	2300	6.78	0.98	10.6
26	Bituminous	2280	10.47	3.10	.....
27	Gas	2260	7.25	3.12	34.0
28	Semibituminous	2250	7.11	0.73	12.9
29	Coke	2190	10.22	1.40	13.9
30	Semibituminous	2170	5.50	0.74	.....
31	Semibituminous	2160	5.70	0.76	.....
32	Bituminous	2140	21.37	.....	.....

mined the iron in the ash, thinking it was an indication of the clinkering property of the coal or coke, while other investigators have attempted to find a relation between lime and clinkers. A miscellaneous group of results as to fusing temperature, ash, sulphur and iron are given in Table 4, arranged in order of their fusing temperature. It is impossible for any one constituent of the ash to be the controlling factor when it is the interrelation of each of the seven or more constituents to all of the others which affects the fusing temperature. It may be possible to ascertain the relative clinkering property of different coals from the complete analyses of their ash, but, so far, no one seems to be able to interpret the results of the analyses after they are made. Making them requires considerable time and is more expensive than is the determination of the fusing temperature of the ash. This one determination gives all the useful information desired from the proper interpretation of the complete analysis of the ash.

The color of the ash is often looked upon as an indication of its clinkering property, but there are so many exceptions to this rule that it cannot be considered a rule at all.

Much work has been done in connection with the preparation of coal at the mines and its effect upon the clinkering property of the coal. In some cases, the better-prepared and lower-ash coals have the higher fusing temperature, while in many others the reverse is true. When the impurities are of a slaty nature, containing a high percentage of alumina, they tend to increase the fusing temperature, while with others, such as lime, an increase may lower the fusing temperature, but if a still larger percentage of lime is added, the fusing temperature may ultimately be raised. Thus it is feasible that coal ash may be treated by adding some material, such as alumina or clay, to reduce the trouble due to clinkers. A larger percentage of ash that will not form clinker is often preferable to a smaller amount that slags or clinkers badly.

The seller of coal cannot guarantee a certain evaporation in a plant because of the varying conditions affecting the boiler efficiency, but he can and does guarantee to deliver coal of a certain heating value. The seller cannot justly be held responsible for trouble due to clinkers when it is the fault of the fireman, but the purchaser can specify the fusing temperature of ash desired and see that it is delivered. This factor is of equal and often of greater importance than the heat value; for what is to be gained by paying a premium for a few extra B.t.u. when the formation of clinker may retard and prevent their development, as clinker affects both the capacity and efficiency of the plant, as well as the repairs to the furnace and its equipment.

Pipe Threading Dies*

No matter of what composition, the greatest difficulty in threading pipe lies in the use of dies which are often inadequate to perform the duties expected of them.

Steel pipe can be threaded just as quickly as iron, its wear is less on the dies and it is preferred by the operator. But to insure a good threaded joint between the pipe and the fitting, a clean, smoothly cut thread must be had, and this can only be secured through a die consisting of a frame and a set of chasers with proper consideration for lips, chip space, clearance, lead and a sufficient number of chasers.

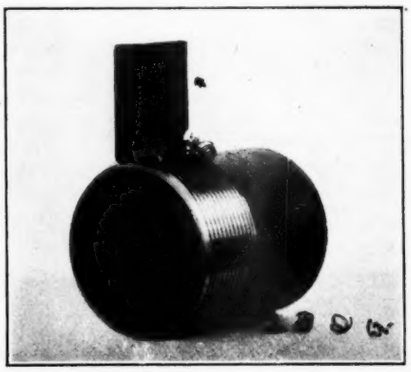


FIG. 1. THREAD CUT WITH PROPERLY MADE CHASER

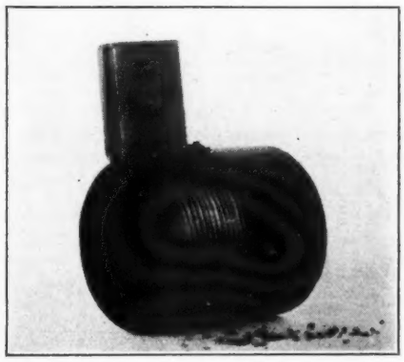


FIG. 2. RESULT OBTAINED WITH IMPROPERLY SHAPED CHASER

LIP

The lip is also known as a hook or a rake, and is the inclination of the cutting edge of the chaser to the surface of the pipe, as shown in Fig. 3.

The lip may be secured by milling the cutting face of the chaser, as shown by the full lines, or by inclining the chaser, as shown by the dotted lines. The lip angle should be from 15 to 25 degrees, depending upon the style and condition of the chasers and chaser holders.

In Fig. 1 is shown a chaser of a properly made die; the chips curl off clean and leave a smooth thread.

A chaser of an improperly made die is shown in Fig. 2; the square cutting edge pushes the metal off, leaving a ragged, torn thread. This die not only makes a poor thread, but also causes excessive friction and is less durable.

CHIP SPACE

This is the space required in the holder in front of the chaser to allow room for the accumulation of chips, Fig. 3, and also provides means for lubricating the chasers. This space should be provided as in Fig. 3, which shows the chip space in front of the chaser, with its back well supported. A lack of chip space will cause the chips to clog and tear the threads.

CLEARANCE

Clearance is the angle between the threads of the chasers and the threads of the pipe. This clearance may be secured in various ways, depending upon the position in which the chasers are held in the frame. The position of the cutting edge of the chaser, in relation to the center line of the pipe while working, determines whether the chasers shall be set "out" or "in" while the teeth are being machined; see Figs. 3 and 4.

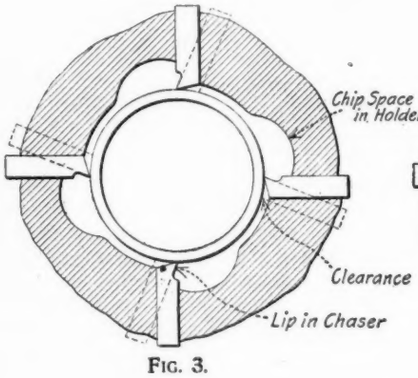


FIG. 3.

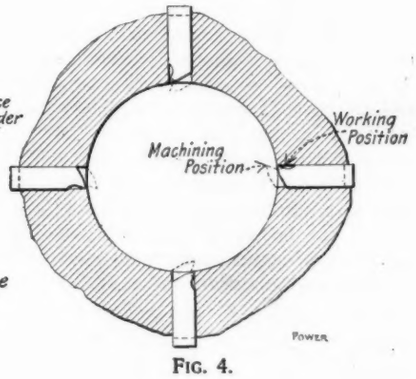


FIG. 4.

LEAD

Lead is the angle which is machined or ground on the front of each chaser to enable the die to start on the pipe, and

*From the September *Bulletin* of the National Tube Company.

also to distribute the work of making the first cut over a number of threads. The lead may be machined on or it may be ground on after the chasers are tempered. The proper amount of lead is about three threads. As the heaviest cutting is done by the lead, it should have a slightly greater clearance angle than the rest of the threads on the chaser. When regrinding a chaser that has become dull on the lead, care should be taken to give each chaser the same length of lead, as otherwise the work will be unevenly distributed between the chasers in the set.

Number of Chasers

To get good results in threading at one cut, a die should have a suitable number of chasers, the approximate number being determined by the size of the die. Dies up to 1¼ inches should have four chasers; 1¼ to 4 inches should have approximately six chasers; 4 to 7 inches, eight; 7 to 10 inches, ten; 10 to 12 inches, twelve; 12 to 14 inches, fourteen; 14 to 18 inches, sixteen, and 18 to 20 inches, eighteen chasers.

Oil

Use good lard or crude cotton-seed oil in liberal quantities, as the best die made will not produce good results with poor oil.

A die made with regard to these points by an experienced toolmaker will thread both wrought iron and steel pipe with equally good results.

Steel pipe is softer and tougher, and consequently is more difficult to thread with the old form of dies having the cutting edge on the center, as shown in Fig. 2; such a die pushes the metal out. A better shape is Fig. 1, which has sufficient front rake and relief to cut the metal out with a clean finish without waste of power or unnecessary friction, similar to the working of a lathe tool.

Applying these principles to hand dies, it is possible for one man to do the work of two. In a paper by T. N. Thomson, read before the American Society of Heating and Ventilating Engineers, in 1906, certain tests are described on the power required to thread pipe with hand dies of the common pattern, and with the same type of dies correctly made. The author says:

"It shows that the power required to thread mild-steel pipe with the new die is not much more than that required to thread wrought iron with the same die, and much less than the power required to thread wrought-iron pipe with the common die."

A patent has recently been granted Henry P. White, of Kalamazoo, Mich., for a novel lubricating material which includes crumpled sheet metal coated with oil and powdered graphite and folded and compacted together.

Steam Driven Air Compressor Economies

By E. C. Sickles

During the past it has been the practice to give but little attention to the cost of operation in the medium-sized compressed-air plants, and in some cases this holds true for the larger plants. First cost has been the main consideration.

Single-stage machines compressing to 90 or 100 pounds have been purchased with simple steam cylinders, operating at 125 pounds steam pressure at the throttle. These have operated for years in localities where the fuel cost is high, and where difficulties were encountered, due to dust and carbonizing effects, with consequent losses in economy and explosions due to extremely high temperature conditions and troubles in lubrication.

Improvements have taken place more readily in the air end by the adoption of the two-stage compressors, with consequent economy, due to intercooling, and ease of lubrication because of lower temperature. In the steam end, however, the most economical arrangement of cylinders and valves has not been followed generally, and there has been considerable loss in fuel economy and through investment for increased boiler plant.

Among steam-driven compressors which have been used to a large extent may be mentioned those employing the Meyer valve on the steam end. This type of valve is customarily used in conjunction with a throttling governor, controlled by air pressure. As the valves are hand set, under varying conditions of load without constant attendance it becomes necessary to arrange the valves to cut off at a fixed point, necessarily so late as to practically eliminate all the economies which might be expected if the compressor were driven under fixed conditions and constant output. If the Meyer valves are set at an economical cutoff, and a heavy load comes upon the machine, it will stop, and, the air supply may be cut off at considerable inconvenience. This type of valve, if the attendant is not on hand to start it, therefore, involves, under varying compressed-air demands, either a loss in economy or constant attendance. The well known throttling type of governor, which is the usual adjunct to this type of compressor, does not permit the highest steam economy.

It therefore becomes necessary, even where the fuel-supply cost per unit is

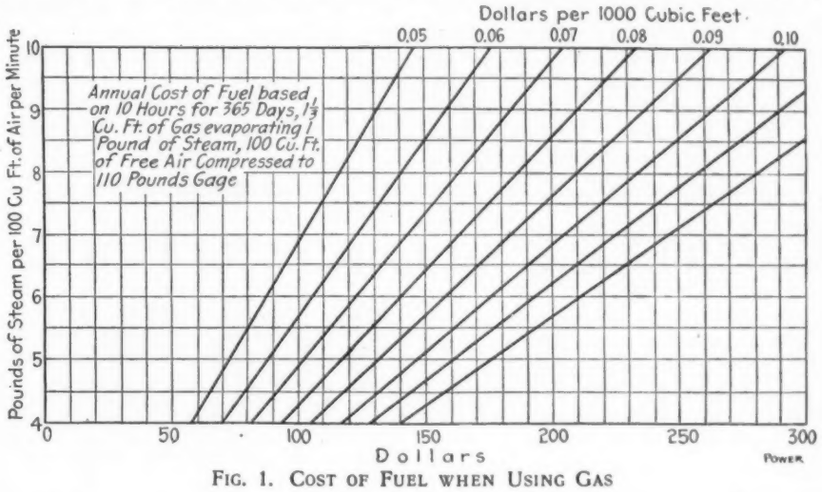


Fig. 1. Cost of Fuel when Using Gas

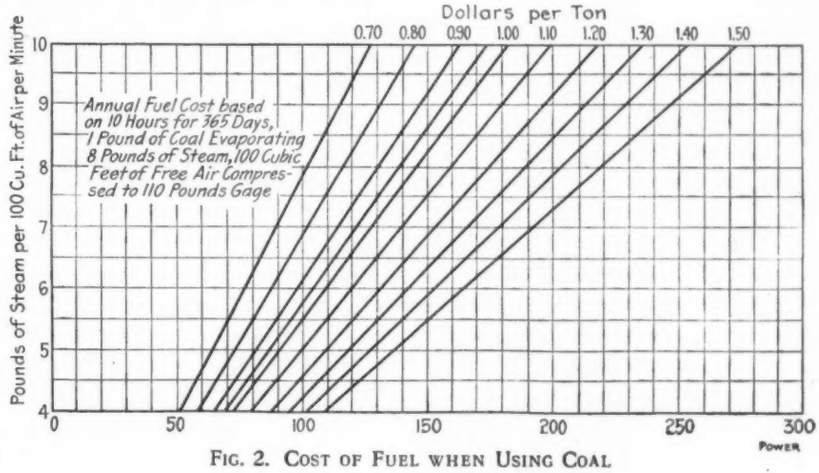


Fig. 2. Cost of Fuel when Using Coal

low, if the most economical commercial results are to be obtained, to consider carefully not only the design of the compressor in detail, but also all the factors entering into the cost of the compressed-air plant. In the cost of a new plant this would involve comparison of the cost of the necessary boiler capacity installed, the cost of the compressor foundations, building and all other factors involved in the complete installation. The annual charges, based upon the total cost of the compressor installed for the same capacity of output, added to the cost of fuel, operation and maintenance costs, will give the proper basis for comparison and decision in the purchase of the most economical compressor.

Since an air compressor is to deliver a certain amount of free air, compressed to a certain pressure, it is desirable in securing bids that the steam consumption be obtained, based upon 100 cubic feet of air compressed to the desired gage pressure.

On the accompanying charts are represented the annual fuel cost of compressed air, based on 10 hours for 365 days, when delivering 100 cubic feet of free air compressed to 110 pounds gage. Fig. 1 represents the cost when gas is used for fuel under the steam boilers, and Fig. 2 when using coal. The price of gas is taken as varying from 5 cents to 12 cents a thousand cubic feet, and the price of coal from 70 cents a ton to $1.50 per ton. As a sample of what may be expected from a compressor of approximately 1200 cubic feet capacity, of compound noncondensing steam end with an economical valve gear and two-stage air end, it might be stated that the steam consumption per 100 cubic feet, compressed to 110 pounds gage, is approximately 6.4 pounds of steam.

Confessions of an Engineer

By W. O. Warren

The pump suction pipes became clogged with dead leaves, which shut down the plant.

Engineer Warren failed to prevent a second shutdown and the manager decided to purchase a double strainer for each suction pipe.

Manager Woods, although kept busy attending to his own department in the factory, found time to drop into the engine room from time to time.

After my experience with the CO_2 recorder I began to look about for some means of making a saving in the operation of the plant, but found no apparent opportunity.

There had been some trouble with the boiler-feed pumps failing, which necessitated shutting down the entire plant on several occasions and the condenser had likewise been put out of service. The frost had been manifest for several weeks and the leaves were fast falling from the trees into the pond from which the boiler-feed water and condenser circulating water were obtained.

When the Trouble Began

I was sitting reading the last copy of POWER (it came in almost newspaper size in those days), when the assistant reported that it was impossible to keep the vacuum at 26 inches and that the engine was running below speed. Almost at the same instant the fireman reported that the steam pumps were not getting enough water to supply the boilers and that he could not keep the plant going much longer as the water was almost down to the bottom gage.

Here was a situation which would make an engineer wish he were a hod carrier. With a limping condenser, an overloaded engine and the feed pump refusing to deliver enough water to the boilers, it was enough to cause the engine-room crew to rush about as franticalyl as rat terriers.

Realizing from the action of the pumps that they were not getting enough water, I at once decided that the strainer on the foot valve had become clogged with dead leaves and grass. The reason that both feed pumps were affected was because they were both connected to the same suction pipe. The condenser circulating pump was connected to a separate suction pipe which entered at the same pit with the pump-suction pipe. The gate was shut in the suction-pipe intake pit and the foot valves were cleaned of their accumulation of leaves. This had necessitated shutting down a part of the mill and Wood was running around as busy as a bird dog.

Little "Rackets" Cost Money

When matters had been straightened out and normal conditions obtained, Wood came into the engine room and said:

"That little racket cost the company over $200."

"Was it as much as that?" I exclaimed in surprise. The fact is, I had never given any time to thinking how much the stopping of the machinery would amount to in wages and decrease in finished products.

"All of that," replied Wood. "We have over 1000 hands employed in the mill and each will average 20 cents an hour. The plant was shut down for more than 30 minutes. That makes a loss of $100 for wages alone and the other $100 is in the loss of output. Dead leaves are costly."

"I should say so!" I exclaimed. "But this has only happened once, or at most twice, a year," I added, with self-satisfaction.

"Once or twice a year is altogether too often," replied Wood. "We have got to find some means of getting over this trouble at once. I suppose a duplicate suction pipe for both the boiler-feed pumps and circulating pump would be about the best way out of the difficulty. Then there will be two pipes to depend upon instead of but one. I would not like to go to the expense of a duplicate line just to prevent trouble for two or three weeks during the year."

"We might put in a screen and do way with the new suction pipe," I suggested, as I labored for something better to say.

"The trouble with such an arrangement," answered Wood, "is that it is only good for preventing large pieces of foreign matter from getting into the suction pipes. In the fall of the year the dead leaves and grass clog them up about as fast as they can be cleaned out, and I do not see that we would be any better off than we are at present.

"I have seen racks and screens used in a great many cases, but they have never been thoroughly satisfactory. I suppose we might fit the intake pit with two screens so that when one gets clogged up it could be lifted and cleaned while the other would be in service."

A Lost Opportunity

Shades of smoke! Why had not I thought of this before Wood did? Here I had been looking the plant over from top to bottom for a chance to make good on improvements and Wood had scored again. I had read the description of a straining device that had been placed upon the market but a few weeks before, and it was just what was wanted. There was no use in crying over sour apples and so I said:

"Why not get one of those new double strainers which have just been put on the market? I know that one on each of our suction pipes will remove the trouble we are having."

"What are they like?" asked Wood. pricking up his ears.

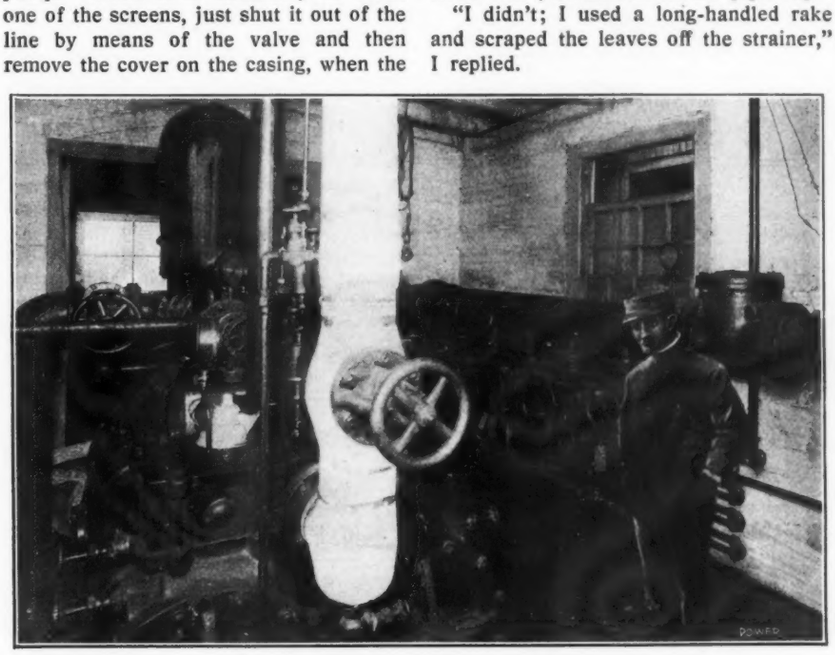
Why, they are just two strainers placed in a metal casing. The casing is fitted with two valves so that the

strainer which is being used can be cut out of the path of the water going to the pump."

"I do not see that this device would help matters much," answered Wood. "When one of the strainers gets clogged up the whole thing has got to be taken up out of the water, which, to my mind, is no better than having a couple of screens to fit in the intake frame and will not cost one-tenth as much."

"Oh, no!" I hastened to reply. "You have not got the right idea. This strainer does not have to be submerged. It can be placed in the suction pipe at any place between the water supply and the pump. When it is necessary to clean one of the screens, just shut it out of the line by means of the valve and then remove the cover on the casing, when the screen is easily removed and cleaned while the other strainer is in service."

"That sounds good, but why in Sam Hill didn't you say something about this thing before? You know that we have had this same trouble year after year and it has cost the company a lot of money first and last."



I Felt Like Kicking Myself for Not Having Had Enough Gumption to Recommend the Purchase of Suction-pipe Strainers

Seeing Ahead

Why? I do not know, unless it was because I was like many other engineers; I was not capable of seeing ahead. I had to have the thing demonstrated before I could grasp the full significance of its utility and value. Perhaps the reason why I had never noted my shortcomings was because I never before had a manager who took any interest in the steam plant.

There was not much that I could say in reply to Wood's question, but I lamely replied: "I did not suppose you would care to put out much money on anything which would be used but once or twice a year."

"Yes, but you knew the value of this strainer device, didn't you?" asked Wood.

"Yes," I said, "I sent for a catalog which described it, as I do for everything I see that is new."

"Well, you knew that we were troubled with leaves clogging up the foot-valve strainers of the circulating pump, didn't you?"

"Yes, I knew about that, but the trouble only occurred once or twice a season and the plant is shut down only about half an hour each time. Besides that, I examine the foot valves about this time of the year to be sure that they are clean."

"How do you clean them? I did not know that you had taken the pipes up."

"I didn't; I used a long-handled rake and scraped the leaves off the strainer," I replied.

"Well, it did not do much good," replied Wood. "I suppose you have done the same thing each season?"

"Sure thing!" I answered with haste, glad to be able to assure him that I had been attending to my work.

"It seems to me that, after finding out that the raking process did not work, you would have looked after some other means of taking care of the foreign refuse matter in the water. I think we will get a strainer for all of our suction pipes and see if we cannot stop this shutting down because a few leaves get into the water. Is there anything better on the market?"

"Nothing that I know of," I replied. "I do not see how anything could be more simple than these strainers. It is simply a matter of cutting the pipe, putting on a flange on each end and screwing these flanges on the pipe to the flanges on the strainer case. After that, as I have told you, it is simply shifting the water from one strainer basket to the other, and then clean the dirty basket."

The Manager Acts

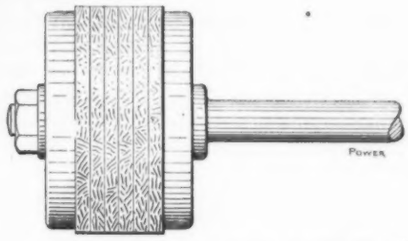
"Well, that looks good to me," and so saying, Wood left the engine room and, as I afterward learned, telegraphed for two strainers for the boiler and one for the condenser circulating-suction pipe.

Here was an opportunity to show that I was capable and was looking out for my employer's interest, but it had gotten past me and had been picked up by Wood while I was looking for something big with which to make a saving.

I have since learned that there are thousands of engineers who are in the same boat; that is, looking for something big to do instead of looking after the small details of power-plant operation.

Leather Piston Packing

A service pump in a street-railroad power plant gave considerable trouble by water slipping past the plunger. The engineer could find nothing that would remedy this trouble until he tried ordinary leather packing rings, six in number, which easily fitted in the water cylinder when dry. These were placed on the piston the same as ordinary packing and the follower plate and nut put in position.



Plunger Packed with Leather

Since using this method of packing the water plunger, the pump will often run 18 months without attention.

A combination of a steam turbine and an internal-combustion engine has been patented by John I. Thornycroft & Co., Ltd., of England, and J. E. Thornycroft, for the propulsion of high-speed vessels, such as torpedo-boat destroyers, in which it is desired to solve the problem of propelling the vessel economically under varying conditions. It provides for an installation of turbine plant equal to the maximum propulsive power required (say, 15,000 horsepower distributed on twin shafts), and for an internal-combustion engine of requisite power to drive the vessel at low or cruising speeds. The internal-combustion engines are preferably oil engines of the Diesel type of 1200 horsepower, in units of 600 horsepower, each on the twin-shaft arrangement. The internal-combustion engine is placed forward of the turbine, and a clutch is provided to couple the engine to the propeller shaft —*Mechanical World.*

"Diamond" Soot Blower

A new design of soot blower has recently been completed by the "Diamond" Power Specialty Company, Detroit, Mich.

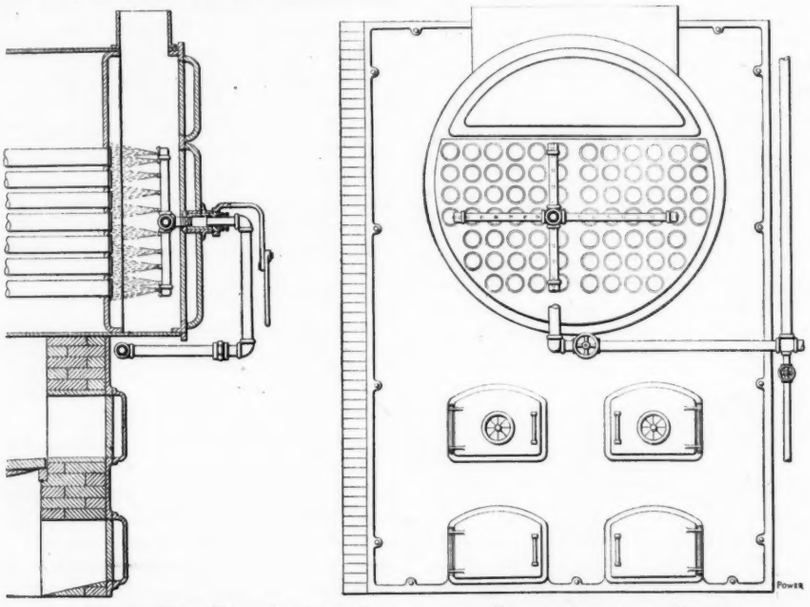


FIG. 1. NEW TUBE BLOWER APPLIED TO A RETURN-TUBULAR BOILER

This front-end blower when used on return-tubular boilers is made with four arms which swing in a quarter circle, and which are operated from the outside of the setting by a handle, as shown in Fig. 1.

The blower is bolted through one of the front doors and each arm is studded with a sufficient number of jets to cover the entire boiler end. There are angle jets on the end of each arm to care for the cleaning of the outside and lower tubes.

The new design of tube blower for Stirling boilers is shown in Fig. 2. It consists of four units. Each unit is equipped with two nozzles and swings in and out of the cleaning doors. One unit is operated at a time and when not in use it is swung to the outside of the boiler setting. Each unit is also provided with a drain cock to free the pipe from condensed steam before blowing the tubes.

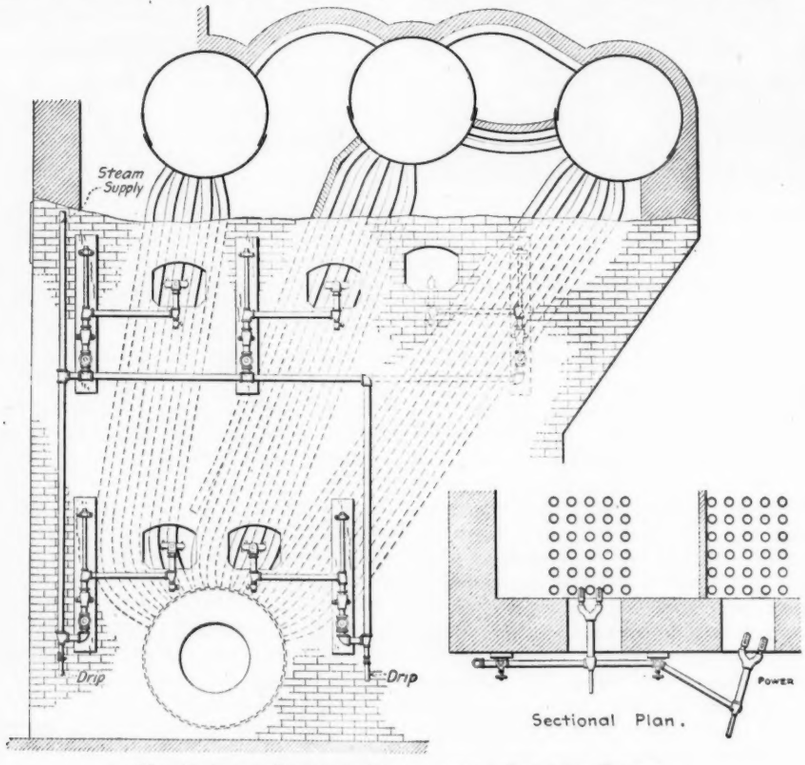


FIG. 2. TUBE CLEANER APPLIED TO A STIRLING BOILER

Belt Hook Tool

A new tool for inserting wire belt hooks in leather belting has recently been patented by A. M. Delvalle, 1432 Pacific street, Brooklyn, N. Y.

The tool shown in Fig. 1 consists of a base upon which the belt is placed and which also holds the belt hook, as shown in Fig. 2.

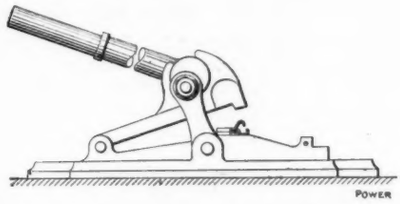


FIG. 1. HOOKS READY TO BE CLOSED

The clamping head is actuated by a handle and ball joint, shown in Fig. 1. When the head is brought down against the hook the top and bottom points are forced into the belting and the two ends are hooked over, one inside of the other. The hooks are held in position in the clamp by a holding plate and rod which passes through the loop of each hook.

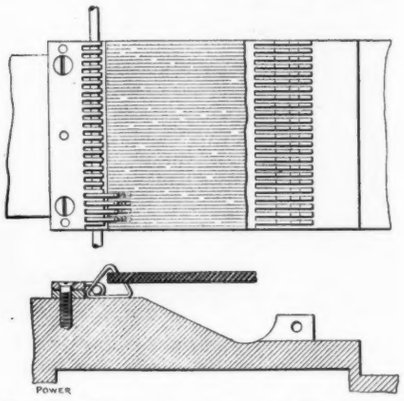


FIG. 2. HOOKS AS THEY ARE PLACED IN THE TOOL

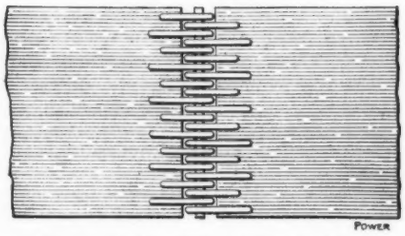


FIG. 3. HOW THE JOINT IS MADE

The hooks are placed in the belt staggered and the links of the hooks in each end of the belt are held together by either rawhide or brass pins, as shown in Fig. 3.

Strode Condenser Packing Tool

A new design of condenser-packing tool has recently been perfected by Edward P. Strode, 131 East Thirtieth street, New York City. The tool is operated by compressed air and is so designed that it winds the packing cord around a spindle and then pushes it into position around the condenser tube when the operator presses a finger and a thumb trigger, which control the two operations.

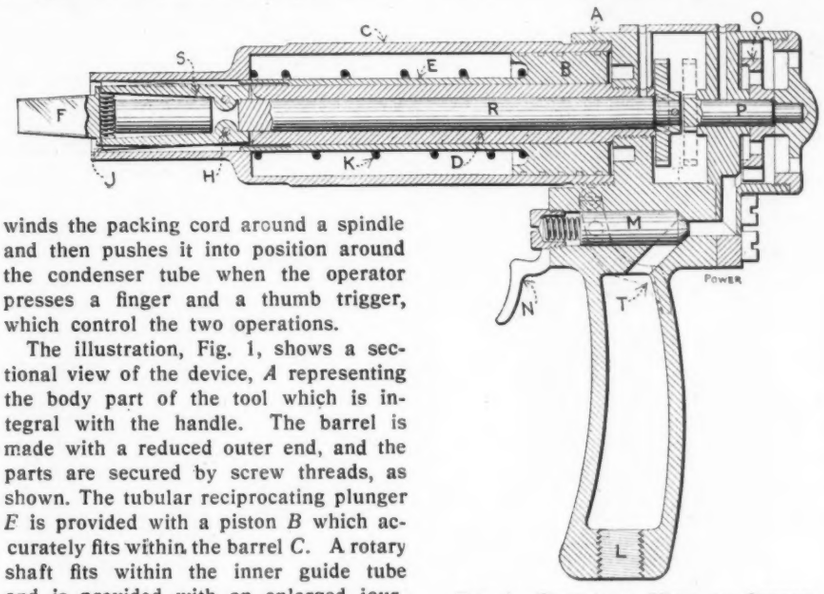


FIG. 1. SECTIONAL VIEW OF STRODE PACKING TOOL

The illustration, Fig. 1, shows a sectional view of the device, *A* representing the body part of the tool which is integral with the handle. The barrel is made with a reduced outer end, and the parts are secured by screw threads, as shown. The tubular reciprocating plunger *E* is provided with a piston *B* which accurately fits within the barrel *C*. A rotary shaft fits within the inner guide tube and is provided with an enlarged journal bearing at its outer end. The end of this enlarged part is turned down into the form of a frustum of a cone, as indicated at *F*, and is provided with a shoulder which fits against the end of the tubes around which the packing is to be inserted. This enlarged part also constitutes a cylinder around which the packing cord is wound before the tool is put into use. To secure this cord a longitudinal groove is provided in the body part in which is pivoted upon a pin *H* a longitudinal finger *J*. It is grooved at its outer end and has a spiral spring inserted in a hole, the arrangement being such that normally this finger is held at its outer end against the inner face of the small end of the barrel. The spiral spring *K* is for the purpose of returning the reciprocating plunger to its normal position after it has been actuated by the compressed air.

A longitudinal slot to the small end of the barrel constitutes an opening for the insertion of the packing cord. The air supply is conducted to the handle of the tube through a rubber tube. In the bottom of the handle is an opening *L* which runs to the body of the valve where it is divided into two channels, one conveying the compressed air to the piston and the other to the driving motor. The valve *M* is held in a seated position by a spiral spring, and the valve is actuated by means of the trigger *N*.

FIG. 2. STRODE CONDENSER PACKING TOOL

The operative part of a rotary motor is shown at *O*. It is secured to the rear end of the breech of the tool and the shaft *P* actuates the rotating shaft *R* of the tool. A detachable cap is secured to the casing of the motor and is provided with a journal bearing. A pinion carried by the shaft *P* meshes with the gear wheel which rotates on a bearing journal that is secured to the breech. Another pinion is carried by a shaft integral with the gear wheel and measures with a second gear wheel that is secured to the rotary shaft *R*. A second valve is kept seated by the pressure of a spring in the channel running to the rotor of the motor. This valve is operated by the lever *T* which is worked by the pressure of the thumb. Air vents are provided for liberating the air after it has passed through the motor.

When using the tool one end of the cord is inserted at the outer end of the slot shown at the small end of the barrel in Fig. 2. Air pressure is then admitted to the motor by merely pressing a trigger with the thumb. The motor rotates the spindle *S*, thereby drawing the cord through the opening and winding it around the spindle. The cord is then in a position to be forced on the tube end by the reciprocating plunger. The operator presses the finger trigger a number of times in succession until the cord has been driven home, the number of blows depending upon the density to be given to the packing. In this way the operator passes from one tube to another in quick succession. The average operator can easily pack a condenser at the rate of from 10 to 15 tubes per minute, and as many as 28 tubes have been packed per minute.

Graspit Belt Dressing

A new preparation has been placed upon the market for cleaning, softening and restoring leather belting to its natural condition. One grade is suitable for use on rubber, canvas and cotton belting, and another grade is made for rope transmission.

This dressing is also suitable for use on oily belts, and after the application has been made and the belt has absorbed the dressing, further oil is prevented from penetrating the leather as the belt has been made water and oil proof. A small quantity of the preservative is put on the face of the belt while it is in motion. It is said by the manufacturers that steam or heat will not affect the belt after this dressing has been used. It is made by the Graspit Manufacturing Company, 723 East Thirty-ninth street, Chicago, Ill.

Twinlok Blowoff Valve

The improved twinlok blowoff valve, illustrated herewith, is manufactured by the Twinlok Specialty Company, St. Marys, O.

The improvement consists of the arrangement of two valves of the rising-stem type with their respective stems parallel and an interlocking tumbler pivoted at *A*, Fig. 1, which is placed between them. This tumbler has a projecting lug so arranged that the valve stem, shown at the right of the illustration, cannot be unscrewed before the stem at the left, upon which is mounted a removable handwheel, is unscrewed to its full hight. When the collar *B* has risen with the steam until it has reached a point opposite the depression *C* in the interlocking tumbler, the handwheel can then be shifted to the right-hand valve stem after moving the interlocking tumbler to the left until the projecting lug disengages the collar, when the right-hand valve stem may be raised to its full hight. It is then necessary to close the right-hand valve before the interlocking tumbler will permit closing the left-hand valve.

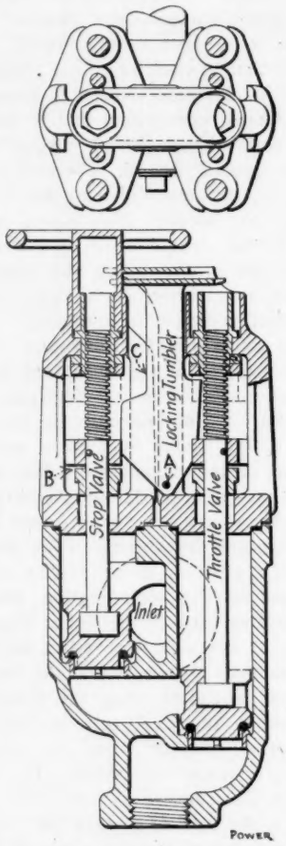


FIG. 1. SECTIONAL VIEW OF TWINLOK BLOWOFF VALVE

This device obliges the operator to open wide the valve nearest to the boiler or high-pressure side before even partly opening the other, and he is likewise compelled to close the latter or throttling valve before he can close the stop valve.

The valve is designed with the idea of bringing all wear upon the outside throttle, the seat and valve of which are renewable.

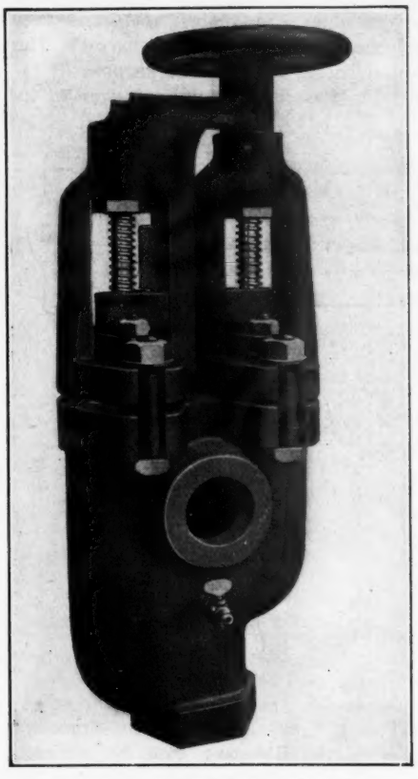


FIG. 2. EXTERIOR OF VALVE

Combination Wrench

The accompanying illustration shows a wrench designed for pipe and other work recently developed by the Atwood Wrench, Tool and Stamping Company, Conneaut, Ohio.

The tool is made of cold-rolled steel, except the smaller parts which are made of tool steel, and the head is welded to the handle after the latter is formed from the flat, thus giving ample tensional strength.

The wrench will take either square or hexagon nuts, and does not have to be taken off the nut in advancing, as it rides around the edges or corners and the grip is taken as desired. It is of the quick-action, self-adjustable type. The clamping effect of the pipe and jaws is obtained through the rotation of a disk which comes in contact with the pipe by means of a spring pulling the saddle toward the head. Pressure on the handle causes the disk to rotate inward, the pinions attached to the disk on both sides engaging the teeth in the handle, thus causing traction toward the head. The grip is, therefore, increased in proportion to the pressure on the handle and is readily released by suspension of the pressure. As will be noted, a three-point contact on the pipe is obtained.

Klie-Rite Pulley Covering

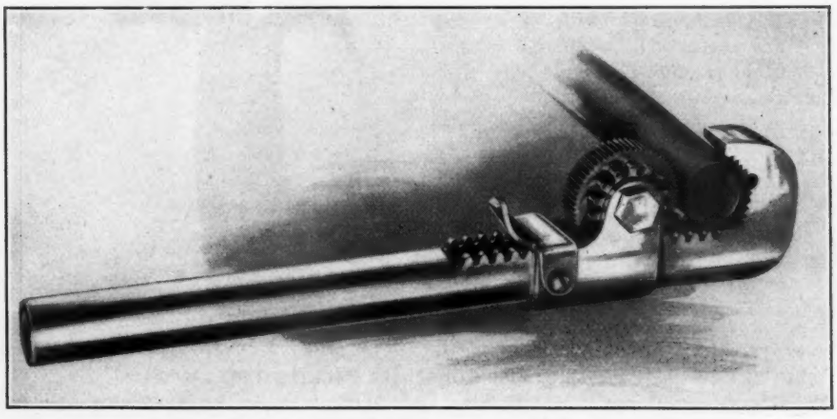
This pulley covering, which has been on the market for a year or more in this country, is being sold under the American rights by the American Klie-Rite Company, 919 Hippodrome building, Cleveland, O.

The preparation, which is an adhesive compound, is applied to the face of a pulley to prevent the belt from slipping.

Duplex Akron Metallic Gasket

The Akron Metallic Gasket Company, Akron, O., is producing a new corrugated-copper gasket which consists of two regular corrugated-copper gaskets which are held together on the inner edge by a double lap. The gasket is then annealed until it is soft and pliable. It is then coated with a graphited cement coating to give contact with the flange, and to prevent sticking to the flange when breaking the joint.

The new gasket is so held together by the double lap that it cannot slip apart, and the double lap on the inner edge gives extra thickness at the place the flanges pinch the least and where the greatest steam pressure comes.



COMBINATION QUICK-ACTING WRENCH

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Power House Lighting

By C. E. Clewell

"We can make repairs much easier and quicker with our new lights; they don't go out just at the wrong time and are steady and don't flicker.

"Our engineer can see all around the machines as well at night or on dark days as in bright daylight; the switchboard man says he can read the instruments quicker and can work on the bus-bars and on the connections behind the boards; also the fireman can see his valves and gages easier. We can find pending trouble before it happens and fix it at once."

Such is the essence of the comments of a station man who had a new lighting equipment installed in his power house. Why had the old arrangement been allowed to go year after year when a change, apparently very simple, had done so much to increase the efficiency of operation of the plant?

To answer this question would be to record the phenomenal development of the past few years in the remarkable inventions of electric lamps and in the great advancement in the methods of installation. These are the chief reasons why lighting results are now possible which hitherto could not be realized. Minor reasons are the previous lack of exact information as to how to distribute lamps in order to illuminate certain apparatus and instruments; how much light was necessary for a given space, and the hight at which lamps should be placed. This article is intended to fit the needs of the station man or superintendent who is responsible for the lighting of his plant, by giving him answers to some of the questions covering the features just mentioned.

Artificial lighting has received little attention in the past because people have regarded lighting as a commonplace subject, devoid of any need for expert consideration. Another reason has been the limited sizes of lamps available. Take the average small power house as an illustration. If the ceiling was low, clusters were used here and there, equipped with carbon-filament lamps, or perhaps arc lamps were utilized, with extension lines for close work. The results of such methods were usually unsatisfactory.

During the past 10 years, however, lamps of intermediate power have been introduced, notably the tungsten-filament, the Nernst and the Cooper Hewitt lamps, all having candlepowers lying between those of the arc and the carbon-filament lamp.

Simple but Important Principles

The station manager should realize that the expense for adequate light is a small outlay when compared with the indirect saving in labor and material in the station upkeep as well as in improved service brought about by time saved in making repairs, locating trouble, etc.

It is most important to choose a lamp adapted to the surroundings and to the class of work performed. Unshaded light shining into the eyes makes it hard to see things even if they are brightly illuminated, especially where the walls and machinery are dark. The way to avoid glare is to raise the lamps so that one is not apt to look into the light itself, and to use reflectors or globes which shield the intense light from the eye.

If all the lamps are on one switch, some are likely to be on when not needed. Therefore it will be found advantageous to control only a few lamps from one switch, so that only those lamps actually needed are burned at any one time.

General versus Definite Rules

Most practical men want definite rules which will give definite results after the work is done according to the rules. This is difficult in lighting work on account of the many variable factors which affect the result. It would be almost as difficult as to specify the station wiring without knowing the allowable voltage drop, the distances involved, the current values and the like. If the ceiling and the walls are dark, more or larger lamps will be required than if they are light colored It is perhaps best, therefore, to give some of the items connected with successfully lighted power houses from which the practical station man may determine for himself whether or not the conditions and the arrangement apply to his own particular case.

The lamps should be operated from constant-voltage mains to prevent the annoyance of unsteady light.

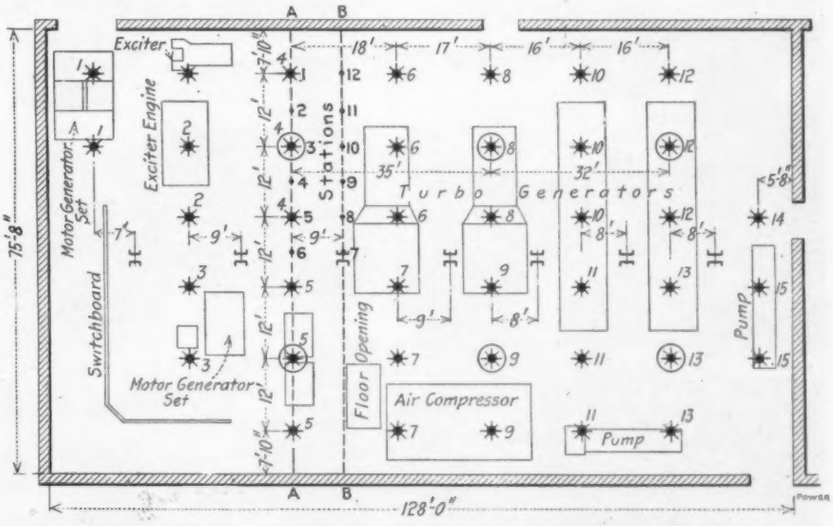


Fig. 1. Showing Old Arrangement of Large Lamps and New Spacing of Small Lamps

Intensity Required

The best and most commonsense test of this item may be summed up in the question: "How well can the work be seen not in a passing glance, but when working under the light for a considerable length of time? After measuring the amount of light found necessary

in the average power house it has been found that from two to three foot-candles* is generally sufficient. This does not necessarily mean that this intensity is needed at all times, but the lamps should be installed so that by a suitable switching arrangement this much light is available at times of emergency when it is imperative to make repairs.

The station man may not be concerned about foot-candles but instead may wish to know how many lamps must be installed to furnish the necessary light. It seems advisable to give general hints only, because cases may occur where adherence to definite rules will produce results far from satisfactory. If the walls and ceilings and general surroundings are dark, more or larger lamps will likely be required than indicated in the following examples. It is advisable, therefore, to consider them as averages which should be used with judgment.

Practical Instances

In one plant 374 feet long by 55 feet wide with a ceiling hight of 65 feet, Cooper Hewitt mercury-vapor lamps were mounted along the walls 25 feet from the floor. In this installation 0.31 watt per square foot of floor space was used.

Another plant, 170 feet long by 59 feet wide with a ceiling hight of 76 feet, was equipped with Cooper Hewitt lamps mounted along the side walls 15 feet from the floor, and here 0.46 watt per square foot was used.

In another plant 0.28 watt per square foot was used in the installation of Cooper Hewitt lamps.

The watts per square foot of floor space required to furnish adequate artificial light depend on the efficiency of the lamp used. For example, more or larger lamps, which give 1 candlepower per watt, will be required than if lamps giving 2 candlepower per watt are used. If tungsten lamps are chosen, it is possible that a somewhat higher number of watts per square foot may be required.

In one power plant having light walls and ceiling, with a floor space 128x75 feet and with a ceiling hight of about 24 feet, 250-watt tungsten lamps were installed with a spacing of 12x16 feet, as shown in Figs. 1 and 2, the lamps being mounted about 21 feet high. The curves in Fig. 3 showing the distribution of light are plotted from observations taken along the lines *A* and *B*, Fig. 1. Here the watts per square foot of floor space were about 1.3. This value is not, however, necessarily an index to the power consumption, for while the value is somewhat higher than those with the Cooper Hewitt lamp, it will be noted by reference to Fig. 1 that the lamps are controlled in such a way that for general lighting every other row may be used, while in case of emergency a given portion of the floor space may be more brightly lighted.

Size of Lamps

In one large factory it has been found that the size of lamps is best governed by the ceiling or the mounting hight. Thus, where the ceiling is low, it was found best to use small lamps to reduce the glare and also to be able to use enough lamps for providing uniform light over every portion of the floor space. For high ceilings large lamps were found to produce good results.

In this instance 60-watt tungsten lamps were used to advantage where the ceilings were 8 feet high or less; for ceiling hights of from 8 to 14 feet, 100-watt tungsten lamps were used in a number of cases; from 14 to 20 feet, both 100-watt and 250-watt tungsten lamps; from 20 to 30 feet, tungsten lamps from 250 watts to 500 watts, and for ceiling hights over 30 feet, arc lamps were used extensively.

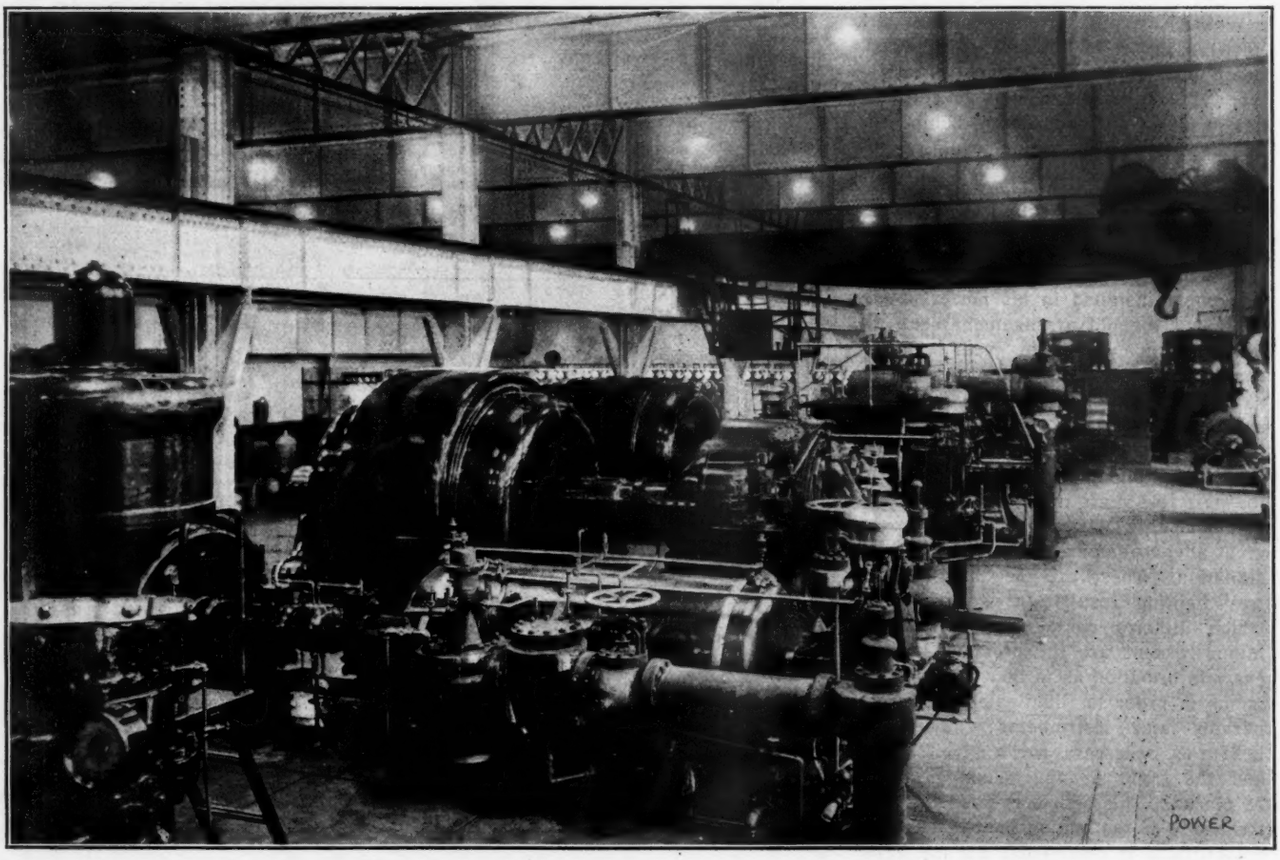


Fig. 2. Showing the Effect of a Large Number of Medium-sized Lamps

*The foot-candle is the unit of illumination intensity and is usually measured on a horizontal plane from 2 to 3 feet above the floor. An incandescent lamp throwing 16 candlepower directly downward, if mounted 4 feet above a desk, will produce an intensity of 1 foot-candlepower on the surface of the desk: if mounted 2 feet above the desk it will produce an intensity of 4 foot-candles on the desk surface. That is to say, the intensity of illumination varies as the square of the distance between the lamp and the plane on which the light is to be used. It is equal numerically to *candlepower* ÷ *hight*^{2}.

Spacing of Lamps

If the size of the lamp is chosen for use in a power house having a certain ceiling hight, the spacing is practically

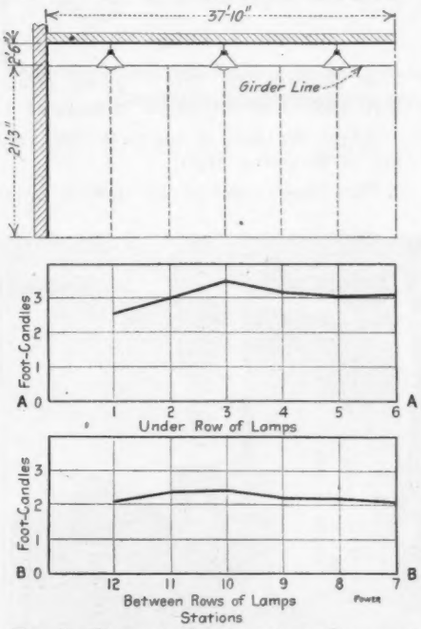


Fig. 3. Showing Intensity of Light at Different Points

in the manner just described, but it has been found expedient to sacrifice symmetry in those cases where a symmetrical placing in the center of bays brings the lamps farther apart than is fitting. In such a case, the spacing having been determined upon equally in both directions, the lamps may be installed so as to clear the girders but need not be symmetrical with respect to them.

Mounting Hight

In power houses the crane often determines the hight at which the lamps must be mounted, unless they are placed along the side walls.

Where there is a light ceiling it is advantageous to mount the lamps close to the ceiling if the lamp is of a type which allows some of the light to be thrown upward, since the ceiling will in turn reflect this otherwise useless light. When the ceiling is very high and the lamps cannot be reached for renewals and repairs from step ladders, it may be best to place the lamps some distance below the ceiling so that they may be reached from the top of the crane. In such a case the ceiling reflection will be sacrificed in favor of a lower maintenance cost. In general, however, lamps should

ficial light is first needed toward the close of the day in the center of the room and later near the windows. With 100-watt tungsten lamps from four to six lamps, and sometimes two lamps per switch, have been used to advantage;

Fig. 6. Cooper Hewitt Lamps in Boiler Room

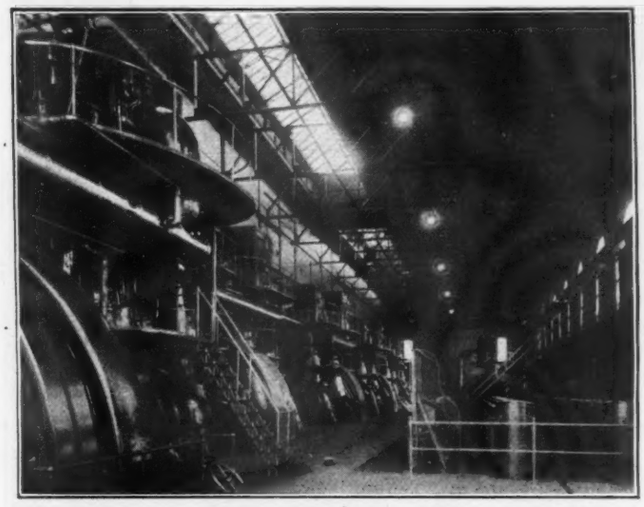


Fig. 4. High Candlepower Lamps in Engine Room with High Ceiling

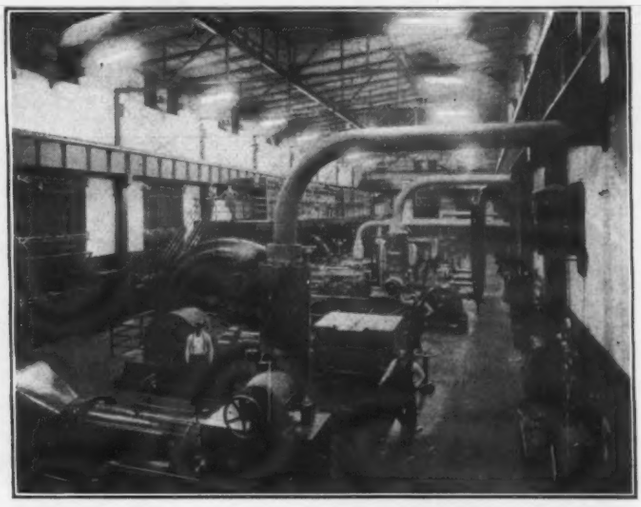


Fig. 5. Good Distribution with Cooper Hewitt Lamps

fixed after the total watts necessary have been found. Consider the power house illustrated in Figs. 1 and 2. If 1.3 watts per square foot were deemed necessary, then the total floor space to be lighted by one lamp is

$$250 \div 1.3 = 192 \textit{ square feet}$$

which is equivalent to a square 14x14 feet. In this particular case the arrangement of the building made it advisable to mount the lamps with a spacing of 12x16 feet so that the lamps might hang in the center of the bays, the area per lamp being the same as before.

The details of the building will often be found to govern the spacing of lamps be mounted high and well out of the line of vision.

When every other place supplied by the power house is in darkness, due to a breakdown, it is important that the power house itself be well lighted so that the necessary repairs may be made with despatch.

Switch Control

The number of switches installed for controlling the lamps should be governed by the floor area covered by one lamp, by the total watts allowable per circuit, and by the location of the windows. It is advisable to control lamps in short rows parallel to the windows since arti-

with the 250-watt lamp two lamps per switch has been found a satisfactory arrangement. In general, the larger the lamps used the larger the portion of floor space lighted by a single unit; hence the smaller should be the number of lamps in a single switch circuit.

Maintenance

Globes and reflectors should be kept clean. Great losses of light occur when these accessories are allowed to become soiled. Frequent washing of the glassware is therefore strongly advised. It has been found in certain very bad cases that nearly double the power is required

to furnish a given amount of light when the lamps and reflectors are soiled as when clean. Burned-out lamps should be renewed systematically and promptly.

Hints for the Various Locations

In the boiler room a row of medium-sized lamps mounted on a level with the upper portion of the boilers has been found advantageous. Individual lamps are placed over the gages and are fitted with metal half shades which throw the light on the gage and at the same time protect the eye from the glare of the lamp. The wiring along the boilers may be placed in approved iron conduit, this making a safe and reliable method.

The basement is usually low and iron conduit is likewise useful here where the conditions are damp. If the ceiling is fairly high, as is the case in some large plants, tungsten lamps may be used in the more open parts of the basement and carbon-filament lamps placed over the pumps, valves, etc.

In the engine room the ideas and principles set forth in the preceding notes particularly apply, and the illustrations show some of the typical power houses which serve as an idea of the general arrangement and the uniformity of the light where the lamps are suitably installed.

As an illustration of an old and a new installation reference is made to the engine room, shown in Fig. 1. The old installation, consisting of six arc lamps, is shown by circles. The watts per square foot of the old installation were about 0.4 while that of the new are about 1.3. The trouble with the old installation lay in the fact that the light was not sufficient and furthermore was thrown sidewise, so that only a small portion reached the floor where it was needed; the lamps were too far apart and as a consequence the spaces between the lamps were poorly lighted. The new installation, consisting of forty 250-watt tungsten lamps, overcame these defects by the use of a lamp small enough so that a large number of them could be used economically and also by the use of a reflector for directing most of the light in a downward and useful direction.

Summary

In summarizing, the following principles and hints should be considered:

Adapt the size of lamps to the ceiling or mounting hight.

The lamps should be spaced symmetrically on squares with respect to the bays if possible and practical, but not if this requires a spacing much in excess of that called for by calculation.

The lamps should be mounted high so as to avoid glare, compensating for this by the use of reflectors.

The lamps and reflectors should be kept clean.

The ceiling and walls should be painted a light color and kept light.

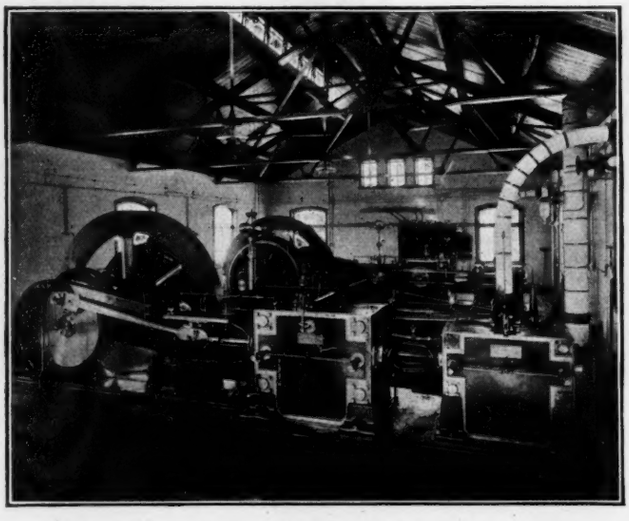


Fig. 7. Clusters of Small Lamps Mounted High but Spaced Too Far Apart

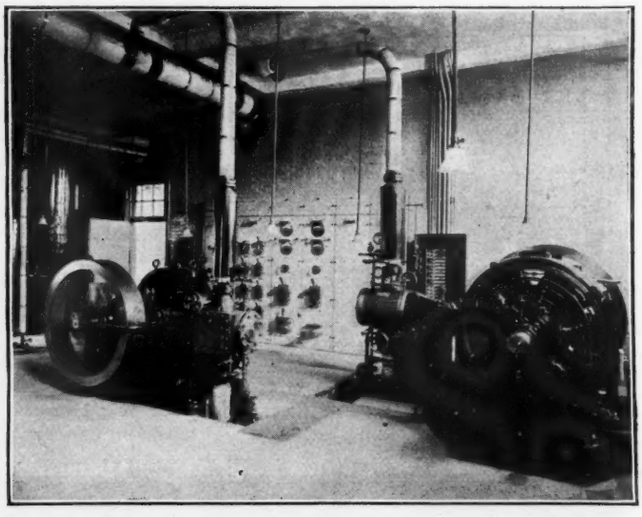


Fig. 8. Individual Lamps Located over Machines, Resulting in Glare and Poor Distribution

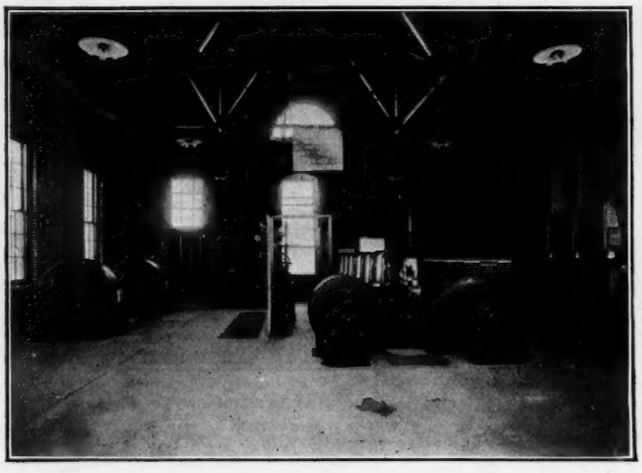


Fig. 9. Light Distributed by Clusters of Small Lamps

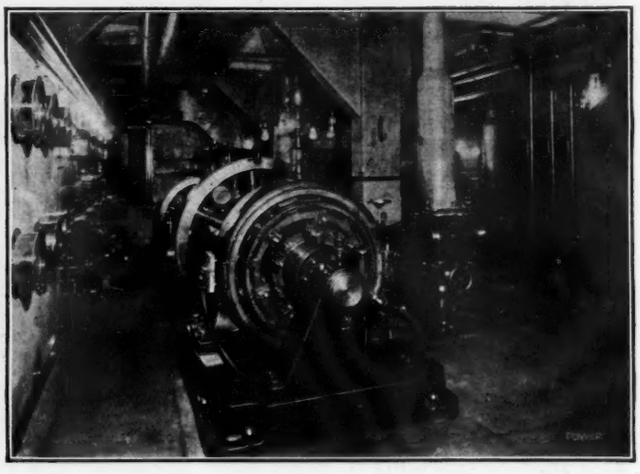


Fig. 10. An Old Method of Lighting—Clusters over Machines

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

The Buckeye Gas Engine

The accompanying engravings illustrate the type of gas engine now being built by the Buckeye Engine Company, Salem, O. The engine has passed through the usual course of evolution in design and the views here shown represent the practically final status.

Fig. 1 is a general view of a tandem double-acting engine, from which it may be seen that the machine is of the side-crank type now generally considered the standard for this country. Fig. 2 is a longitudinal section of the same engine. The main frame carrying the crosshead guides and the main bearing is anchored positively to the foundation, but the intermediate and tail frames are so mounted that they can slide in guides on their respective sole plates. The method of attaching the cylinder to the main and other frames is so clearly shown in Fig. 2 as to render a description unnecessary. The main and intermediate crosshead guides are of the "bored" type such as has been used for years on the well known Buckeye steam engine; the tail guide is also machined to a circular arc, although there is only one guide surface.

The engine operates on the four-stroke cycle, and as to the general features of construction it does not differ essentially from other American engines of its class. The chief differences are in the valve gear, the method of governing and the arrangement of the piston-rod packing.

Fig. 3 is a cross-sectional view of one end of a cylinder, showing all of the elements of the valve-gear and governor mechanism. The main admission valve *I* and the exhaust valve *E* are operated from a single eccentric through wiper cams in the well known manner. To the end of the admission-valve rocker arm is pivoted a lever *B* and the outer end of this lever is

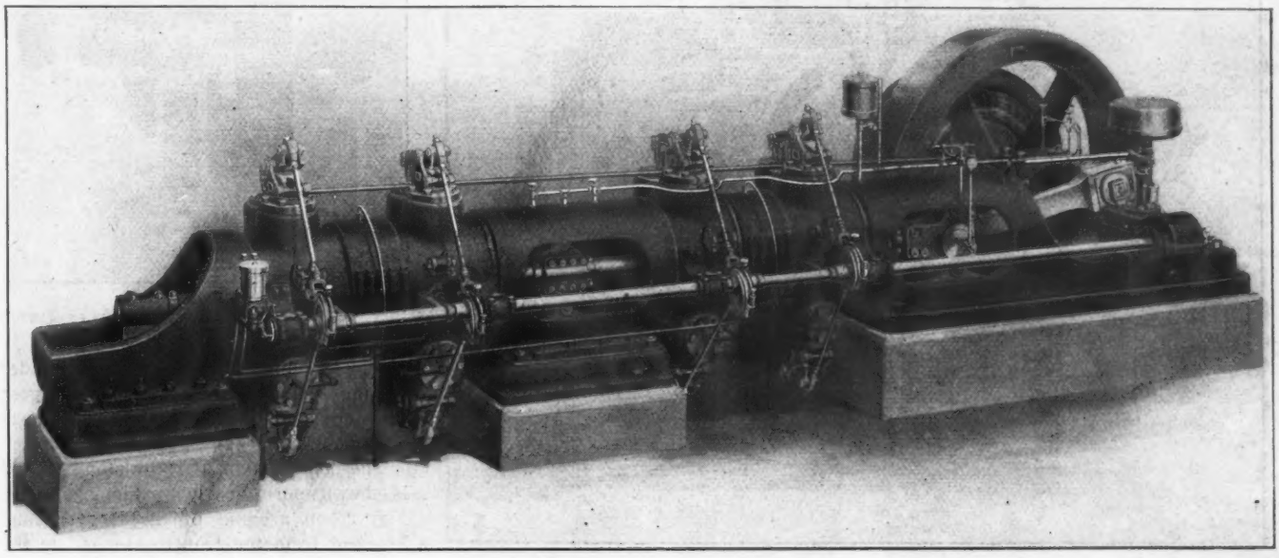


FIG. 1. TANDEM DOUBLE-ACTING BUCKEYE GAS ENGINE

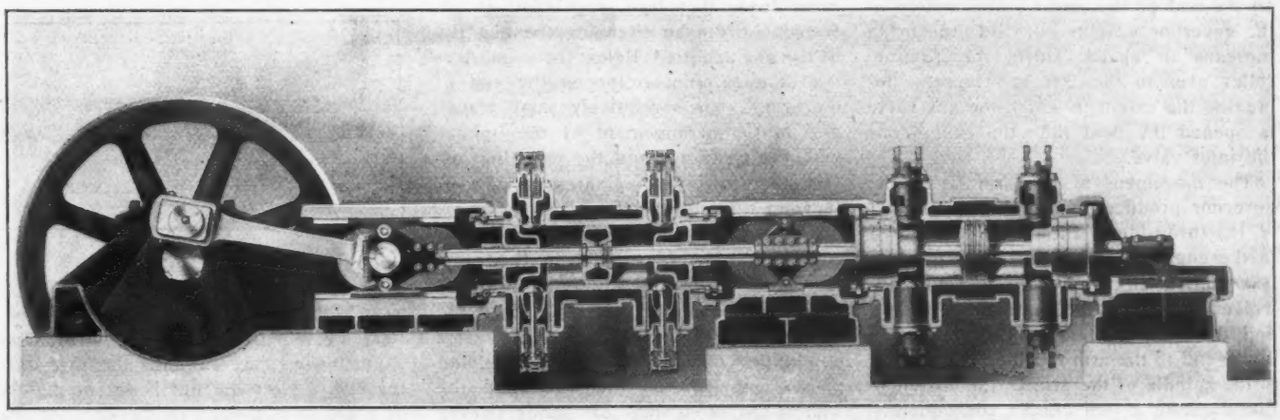


FIG. 2. LONGITUDINAL SECTION OF TANDEM ENGINE

pivotally attached to the stem of the gas valve *G*. The lever *B* fulcrums on a roller on the end of an arm *C* which is oscillated by the governor so as to shift the point of the fulcrum nearer to or further away from the end of the lever. That part of the lever which rests on the roller is curved to a radius having its origin in the center of the pivot upon which the arm *C* is mounted, in order that the governor may shift the position of the arm *C* without changing the position of the gas valve *G;* this construction also avoids subjecting the governor mechanism to any increase or decrease in friction between the roller and the face

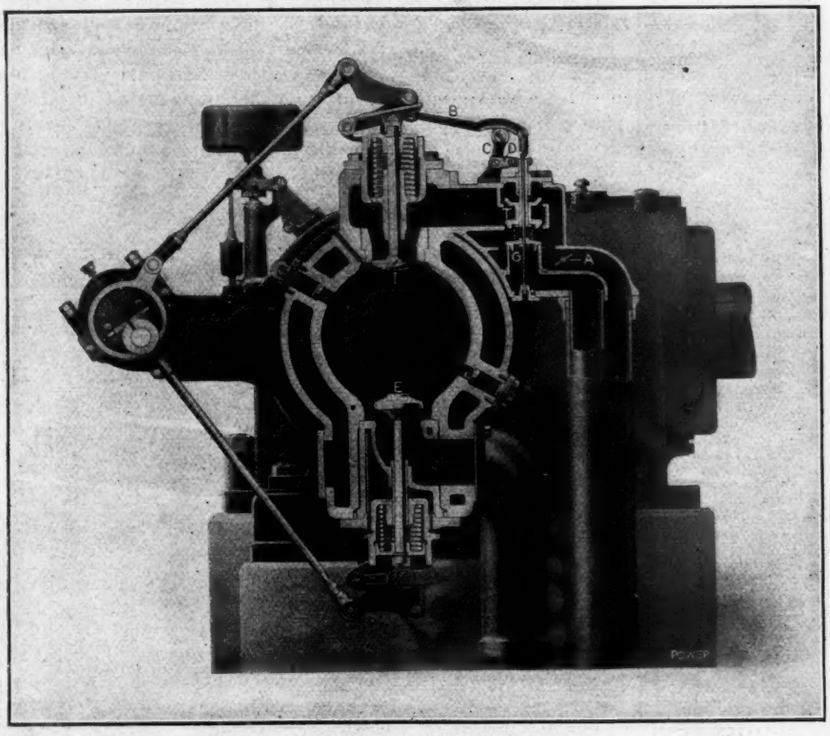


FIG. 3. BUCKEYE VALVE GEAR

of the lever *B* when the arm *C* is being shifted. As the travel of the main inlet valve is always the same, the extent to which the gas valve *G* is opened depends upon the position of the fulcrum roller on the end of the arm *C;* any motion of the governor weights outward, due to an increase in speed, shifts the fulcrum roller over to the left and thereby decreases the extent to which the gas valve is opened the next time the cam opens the inlet valve.

The movement of the arm *C* by the governor produces another result, namely, the throttling of the mixture delivered to the engine. The double-cone valve *T* is mounted on a tubular stem through which the stem of the gas valve *G* passes and the tubular stem is attached at its upper end to the arm *D* which is fastened to the spindle of the arm *C*, the combination forming a bell crank; consequently when the governor shifts the fulcrum roller to the left to decrease the travel of the gas valve it also lowers the throttle valve *T* and thereby reduces the area of the opening through which the mixture must pass to the main inlet valve.

The butterfly valve *A* is adjusted by hand to regulate the proportions of the mixture if that should be necessary. Ordinarily, however, the gas valve *G* is made of such a size with relation to the air passages as to form the proper proportion of gas to air for the kind of gas on which the engine is to run, and as long as the gas quality remains fairly constant the butterfly valve *A* is left practically wide open. The various levers and the throttling valve *T* just mentioned are so proportioned that the mixture is not appreciably throttled until the load decreases to about three-fourths of the rated load; between this point and maximum load, therefore, regulation is effected entirely by changing the quantity of the gas admitted. Below three-quarters load the fulcrum roller on the end of the arm *C* has a relatively small travel, due to the arrangement of the linkage with the governor, and the throttling effect, therefore, predominates very greatly from this point down to no load.

The exhaust valve is water-cooled, of course, and its construction is illustrated in Fig. 3. The stem is tubular and a small pipe extends through it into the hollow head of the valve; cooling water is admitted through the central tube and passes out between that tube and the wall of the valve stem. The guide sleeves for the valve stem are provided with a long bushing which is renewable when wear makes this necessary. The valve cage is also water-cooled.

The valve-gear shaft, which extends alongside the cylinders as usual, is driven through bevel gears and a drag crank from the outer end of the main crank pin. This arrangement is shown in section by Fig. 4, which also shows that the governor is driven by bevel gears from the countershaft between the drag crank and the gear of the valve-gear shaft. This relieves the governor from disturbances due to torsional deflections of the valve-gear shaft.

The mixing chamber and the exhaust

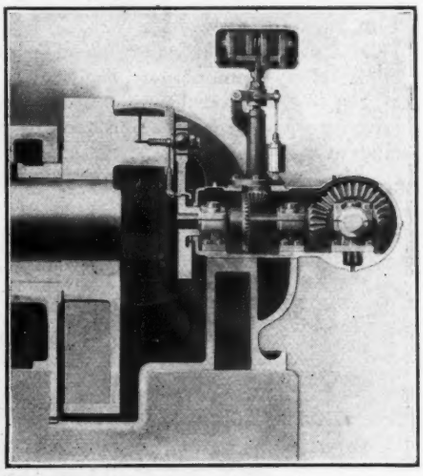


FIG. 4. GOVERNOR AND LAY SHAFT DRIVE

pipe are bolted directly to the cylinder casting independently of the valve cages; the latter, therefore, may be removed without breaking any pipe connections.

The construction of the piston and rod is shown more clearly by Fig. 5 than by Fig. 2, on account of the larger scale. The rod from the front crosshead to the intermediate crosshead is continuous, but there is a short length of enlarged diameter at the center and an integral collar at one end of this enlarged diameter; the other end is threaded to take the clamping nut which holds the piston against the collar. The diameter of the rod from the threaded portion to the end

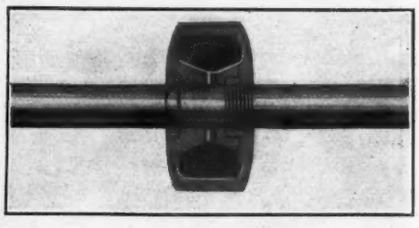


FIG. 5. PISTON CONSTRUCTION

is smaller than that of the threaded portion so that the nut may be readily slipped over the rod until the thread is reached. After the nut is set up tightly in place it is pinned to the face of the piston so that it cannot back off. The

other face of the piston and the collar on the rod are similarly pinned together to prevent the piston from turning on the rod. This is necessary both for the purpose of maintaining the alinement between the inlet and outlet water passages in the wall of the rod and in the core of the piston and in order to prevent the nut from being backed off the thread on the rod. The two piston rods are exactly alike and therefore interchangeable.

The connecting rod is of the solid-end type with mortises for the boxes cut through the solid slab. Wedge adjustment is provided for the boxes at both ends. The crank, counterweight and crank pin are all in one casting of steel.

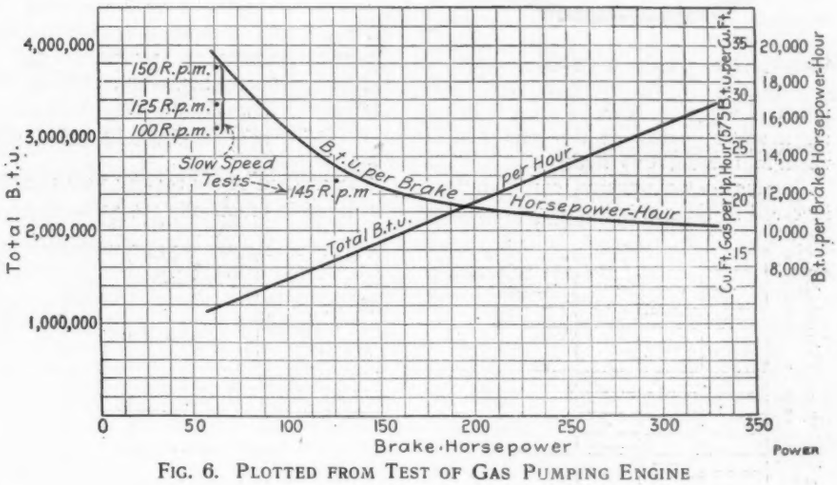


FIG. 6. PLOTTED FROM TEST OF GAS PUMPING ENGINE

The crosshead shoes are pivotally attached to the crosshead block in order that they may remain true with the guides regardless of any bending of the piston rods; this is true of both crossheads and the tail shoe.

In the application of the piston-rod stuffing boxes a considerable departure has been made from the original practice of setting the packing-ring housings inside the rod guides. As may be seen in Fig. 1, the packing-ring housings are attached to the outside faces of the cylinder heads and are, therefore, easily accessible without disturbing the heads; this also permits the cylinder heads to be uniformly cored and cooled.

Ignition is effected by means of make-and-break igniters, electromagnetically operated and supplied from a storage battery which is kept charged by means of a small dynamo driven by the engine. An automatic cutout, operated by a solenoid, disconnects the dynamo from the battery when the dynamo voltage is either too low or too high for the storage battery. In all of the double-acting engines two igniters are provided in each end of each cylinder and provision is made for starting with compressed air.

The engines are also made in single-acting form, both single cylinder and tandem, and each of these is made in twin form; in fact, they are built in any combination from the single-cylinder single-acting type up to the double-acting twin-tandem type.

Fig. 6 was plotted from the results of some tests recently made on a double-acting tandem engine at the Flatbush pumping station of The Flatbush Gas Company, Brooklyn, N. Y. The engine has cylinders 18 inches in diameter and a stroke of 24 inches; it is used to drive a gas pump and is rated at 335 indicated horsepower at 175 revolutions per minute. As the chart indicates, the load was carried slightly beyond 330 brake horsepower. The four observation points below the left-hand third of the economy curve indicate readings taken at the speeds stated, and show the influence that reducing the speed exerts on the friction losses.

LETTERS

Points in the Care of Oil Engines

I have read J. S. Leese's article on the care of oil engines, in the October 24 issue, with much pleasure and profit, but there are three points on which I should like more information.

(1) I can hardly see how the trouble of an engine stopping a few minutes after starting up can be laid to the ignition tube not being hot enough. My experience has been that the engine will not start at all if the tube is not hot enough.

(2) With a properly designed bunsen burner and tube which only allows the flame to strike it in the correct place for timing the ignition (though as a rule an engine is provided with a timing valve), I fail to see how one can get the ignition tube too hot if one tried. I have had quite as much trouble from preignition with electric igniters as with the hot tube.

(3) Why should the exhaust valve of the engine be left open? I have always been under the impression that it was the best practice to leave all valves shut for the protection of the valve seats.

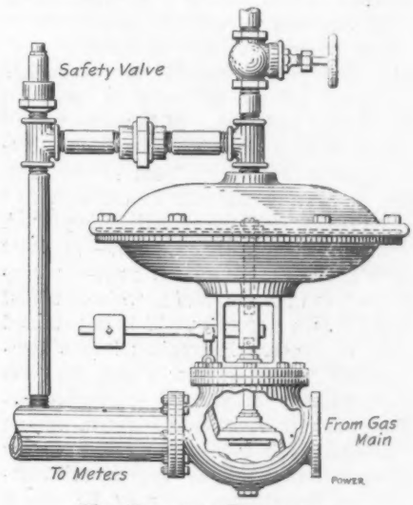
S. G. ROSE.

Brockville, Ont.

Why the Engines Stopped

In a power plant consisting of six 14x18 three-cylinder vertical engines and one 16x18 horizontal single-cylinder engine, all of the four-stroke type and operating on natural gas, the ignition current is normally supplied by a motor-generator set, and a set of battery cells is used for starting the first engine.

At about 10 o'clock one morning, all of the engines stopped dead. We thought possibly a fuse had blown on the motor side of the motor-generator set, and attempted to start up as usual on the battery, but could only get a few impulses, after which the engine would stop. Upon testing out the ignition system we found we were getting plenty of current and a good spark, so we investigated the gas pressure. The pressure regulator in the meter house indicated that the gas pressure was very low, the spindle of the regulating valve being in the full open position. We sent for the "gas man," but he could not suggest anything. He said he had 18 pounds pressure on the main line, so we figured the trouble must be in the regulator. Upon taking out the plug in the bottom we discovered that the valve disk had become detached from the stem and dropped down on its seat, thereby shutting off the supply of gas. Upon taking the regulator apart it was found that the nut which slips down over the valve stem and screws into the valve had come unscrewed.



THE PRESSURE REGULATOR

The accompanying sketch clearly shows the construction of the regulator, but no one as yet has been able to account for the valve nut becoming unscrewed.

H. H. DANIEL.

Titusville, Penn.

Refrigeration Department

Principles and operation of ice making and refrigerating plant and machinery

Cooling Air of Buildings by Mechanical Refrigeration

By E. F. Tweedy

One frequently hears expressions of surprise over the fact that the artificial cooling of the air in dwellings, public buildings and places of amusement is not more general. Why is it that in modern social and industrial life there has not been felt the necessity of maintaining homes and places of business and of pleasure at a temperature as conducive to comfort during the heat of the summer as during the cold of the winter.

To begin with, the period during which artificial cooling is required—at least throughout the temperate zone—is very much less than the time in which artificial heating is a necessity. If it is assumed that 70 degrees Fahrenheit is the temperature which is most pleasing to the vast majority of persons—admitting the fact that one occasionally encounters an individual who evinces a preference for a temperature of 60 degrees Fahrenheit or thereabouts—it may be noted, from a glance at Fig. 1, how small that portion of the entire year is in which the average outside temperature is in excess of 70 degrees Fahrenheit, and, by comparison, how large the portion is during which the outside temperature is below 70 degrees Fahrenheit. The stepped curves of Fig. 1 show the mean monthly temperatures throughout the year of New York City, Chicago, Portland, Me., and New Orleans, respectively, the temperatures as given being averages for a long period of years. It may be seen that in no month during the year does the mean temperature of Portland, Me., reach 70 degrees Fahrenheit, while in New York City and Chicago a higher mean temperature than 70 degrees Fahrenheit exists only during some two months of the entire year. Even in the case of New Orleans, only five months in the year show a mean monthly temperature in excess of 70 degrees Fahrenheit.

Air cooling has already assumed commercial importance in several industries, notably in the manufacture of chocolate and in the operation of blast furnaces. Before chocolate-manufacturing plants were artificially cooled, it was difficult, if not impossible, to continue the operation of such plants during the extremely warm portion of the year. In the case of blast furnaces, the air is cooled for the purpose of removing its moisture, thereby making it possible to reduce slightly the amount of coke used, inasmuch as when moisture is present in the air a small portion of the total fuel is used in heating this moisture.

Coming to the physical considerations involved in the cooling of air, the fact is presented that air is, in reality, a mixture of air and water vapor. When air is warmed, this moisture is heated along with the air, but its weight is so small compared to that of the air that the presence of this moisture, so far as having any effect upon the quantity of heat required, can usually be ignored. When air is cooled, however, the moisture in the air must be removed step by step, provided a condition of saturation is reached—a condition always to be met with in a practical case of air cooling. The removal of this moisture in the air necessitates the abstraction of an amount of heat for every pound of vapor present equivalent to the heat of vaporization of water, which is, roughly, 1000 B.t.u. per pound. In addition, a quantity of heat must be removed from the air itself, and this quantity is represented by the product of the number of pounds of dry air present, the specific heat of air, which is usually taken at 0.238, and the range of temperature through which the air is cooled. A small additional quantity of heat must be removed in order to cool the varying amount of vapor present from its initial to its final temperature. This quantity is relatively so small—probably averaging 2 or 3 per cent. of the total heat abstracted in cooling the air and removing the moisture—that it can be practically neglected, although an additional allowance of some 2 or 3 per cent. is frequently made to cover this item.

The method of air cooling now usually employed is practically the same in principle as the indirect system of heating. Air is forced by a fan through refrigerating coils, and frequently water is sprayed over these coils as the air is passing through them, the water thus serving to wash the air and, at the same time, to cool it. When ammonia is the refrigerating agent, it is usual to circulate refrigerated brine through the coils, but when carbonic acid is the refrigerating medium, direct expansion usually takes place within these coils, thus dispensing with the use of refrigerated brine. From the cooling chamber the air is led through ducts to the room or rooms to be cooled. The quantity of air thus circulated in a given time between given temperature limits and from a given initial relative humidity determines the capacity of the refrigerating machine.

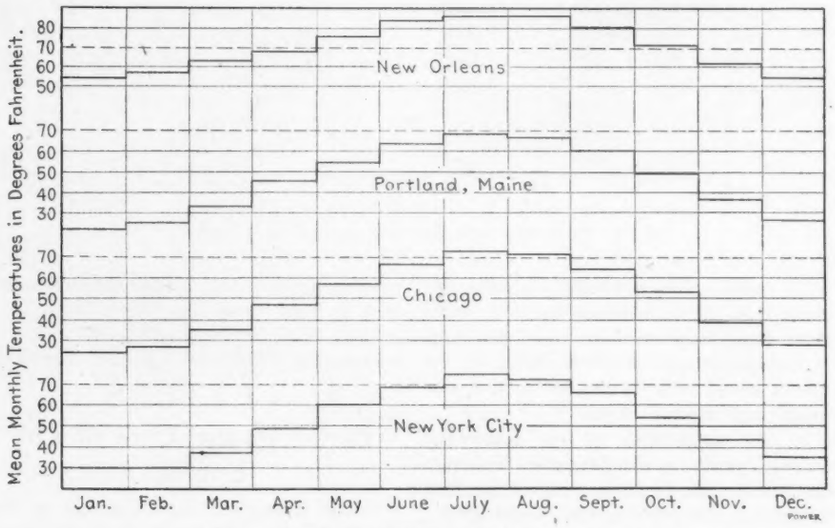


Fig. 1. Average Monthly Temperatures

Some idea of the amount of heat produced by a few of the more common types of illuminants is given in the accompanying table, which is based upon data compiled by various authorities.

HEAT PRODUCED BY COMMON TYPES OF ILLUMINANT

Type of Illuminant	Quantity Consumed per Hour		Candlepower of Illuminant	Heat Produced per Hour in B.t.u. (Approx.)
	Grains	Cubic Feet		
Tallow candle	2200	...	16	5600
Kerosene oil	909	...	16	4100
Coal gas, bat wing burner		5.5	16	4100
Coal gas, Welsbach burner		3.5	50	3000
6-glower Nernst			400	1800
Enclosed arc lamp (600 watts)				2000
50-watt, carbon filament incandescent lamp			16	170
25-watt, tungsten filament incandescent lamp			20	80

While the values given in the table are only approximate, the superiority of the electric light as a nonheat-producing form of illuminant is very clearly shown. Moreover, the incandescent electric lamp possesses the material advantage of not consuming the oxygen of the air and of not vitiating the air with any products of combustion.

In order to show the application of some of the principles which have been enumerated above, a practical case of air cooling, to meet certain specified conditions, will be worked out in detail. We will assume, for convenience, a large room, 100 feet square and with a 30-foot ceiling and exposed to the outside air on all four sides. If the specifications stipulate that the temperature of this room shall not exceed 75 degrees Fahrenheit when the outside temperature is at 90 degrees Fahrenheit, it might readily work out that the total amount of heat entering this room through the side walls, windows, floor and ceiling would amount to some 200,000 B.t.u. per hour. The following additional assumptions will be made: The room is to accommodate a maximum of 500 people; it is to be lighted by 300 twenty-five-watt tungsten lamps, and the relative humidity within the room is not to exceed 60 per cent. when the relative humidity of the outside air is 80 per cent. for the limits of temperature as given above.

Upon the assumption that the persons who are to occupy this room are to be at rest, take a heat emission of 400 B.t.u. per person per hour, which for a maximum of 500 people would amount to 200,000 B.t.u. per hour. Referring to the table showing the heat given off by various types of illuminants, take the value of 80 B.t.u. as the amount of heat given off per hour by a 25-watt tungsten lamp. The total amount of heat emitted per hour with the entire lighting installation in use would, therefore, amount to 24,000 B.t.u. It thus appears that the refrigerating plant must be capable of removing from the room under consideration a total of approximately 424,000 B.t.u. per hour.

The next step is to select the range of temperature through which the air shall be allowed to warm while passing through the room. It is desirable from a refrigerating point of view that this temperature range be as great as possible, and thereby reduce the total quantity of air which must be circulated, but, as previously noted, there are certain practical limitations to such a procedure. Assume a temperature rise within the room of 15 degrees, the air entering at 60 degrees and leaving at 75 degrees Fahrenheit. As there will be an unavoidable rise in temperature between the cooling coils and the points where the cool air enters the room, let it be assumed that the air will leave the cooling coils at a temperature of 55 degrees Fahrenheit. Taking the specific heat of air as 0.238, it will be found that approximately 120,000 pounds of air must be supplied per hour to remove the total amount of heat determined above, with a temperature rise of 15 degrees within the room. This would be equivalent to over five changes of air per hour and would afford excellent ventilation for the maximum number of people which has been assumed.

The amount of moisture present for each pound of dry air is calculated for the assumed outside temperature of 90 degrees Fahrenheit and 80 per cent. humidity, as may easily be done by consulting a table showing the properties of saturated air at various temperatures, and if then a similar calculation is made to determine the amount of moisture present with each pound of dry air at a temperature of 55 degrees Fahrenheit, which is the temperature at which the air is assumed to leave the refrigerating coils in a saturated condition, it will be found that approximately 15.5 pounds of moisture must be condensed for each 1000 pounds of dry air supplied. As it has already been found that the required quantity of dry air is 120,000 pounds per hour, it is evident that about 1860 pounds of moisture will be condensed per hour, requiring an abstraction of heat amounting, roughly, to 1,900,000 B.t.u. per hour. Allowance must now be made for the rise in the temperature of the air during its passage from the refrigerating coils to the room outlets. As a 5-degree rise in the temperature of the air while passing through the ducts has been assumed, the total gain of heat from this source will be

$$5 \times 0.238 \times 120{,}000 = 143{,}000 \ B.t.u.$$

approximately. The total amount of heat the refrigerating plant must be capable of removing per hour is, therefore, as follows:

	B.t.u.
Heat radiated through walls, windows, floor and ceiling	200,000
Heat emitted by human occupants	200,000
Heat resulting from illuminants	24,000
Heat of liquefaction of vapor removed by condensation	1,900,000
Heat gained in passage through ducts after leaving refrigerating coils	143,000
Heat between 90 and 75° F	428,400
Total	2,895,400

The capacity of a refrigerating machine is expressed in tons of refrigeration, a ton of refrigeration being equivalent in cold-producing effect to the melting of one ton of ice in 24 hours. One pound of ice, in changing into water at the same temperature (32 degrees Fahrenheit), absorbs from its surroundings approximately 142 B.t.u.; therefore, the melting of one ton of ice is accompanied by an absorption of heat amounting to 284,000 B.t.u. The "ton of refrigeration," or "ton of refrigerating effect," is, therefore, equivalent to the removal of 284,000 B.t.u. in 24 hours, or of 12,000 B.t.u., roughly, in one hour. Hence, by dividing the total number of B.t.u. which the refrigerating plant must remove per hour, as given, by 12,000, it is found that it should have a capacity of approximately 240 tons of refrigeration. Allowing an additional 2½ per cent. for the cooling of the varying amount of vapor present with the air, the required refrigerating capacity would be about 246 tons.

One of the conditions assumed in the foregoing problem was that the final relative humidity within the room should not exceed 60 per cent. For any given temperature to which air is cooled, the final relative humidity will depend upon the range of temperature through which the air is afterward allowed to warm, assuming the air to be in a saturated condition when it leaves the cooling coils—a condition always to be met with in problems of air cooling. This is due to the fact that a given weight of air, when leaving the cooling coils, carries with it a definite weight of moisture, and this weight remains constant inasmuch as the air passes over no water and hence has no opportunity for gaining any additional moisture. Saturated air at 55 degrees Fahrenheit, if warmed to 75 degrees Fahrenheit, will have a final relative humidity of approximately 50 per cent. This is sufficiently below the limit specified in the problem to provide for the unavoidable increase in moisture which would result from the people present in the room.

The accompanying chart, Fig. 2, is reproduced from a paper upon the subject of air cooling read by W. W. Macon before the American Society of Heating and Ventilating Engineers. It affords a very convenient method of determining the approximate refrigerating capacity required for a given case of air cooling after the necessary preliminary calculations have been made to determine the requisite volume of air to be supplied. The chart was derived from another chart

showing the B.t.u. which must be removed per pound of dry air for cooling the air and for condensing the accompanying vapor, the heat units per pound of dry air being converted into tons of refrigeration per 1000 cubic feet of air by assuming an average value of 0.07 pound as the weight of dry air in a cubic foot of a mixture of air and vapor. The variation from this value is not great for the range of temperatures and percentages of humidity found in an ordinary case of air cooling, the actual weights ranging from 0.0659 for air at 102 degrees Fahrenheit and 100 per cent. humidity, to 0.0737 pound for air at 72 degrees Fahrenheit and 50 per cent. humidity.

To show the method of applying this chart, it will be employed for determining the refrigerating capacity under the conditions of the problem already worked out. It was found that approximately 424,000 B.t.u. must be removed from the room each hour, with the air entering the room at 60 degrees and leaving it at 75 degrees Fahrenheit, a rise of 15 degrees. One cubic foot of a mixture of air and vapor at a temperature of 60 degrees Fahrenheit with a relative humidity of approximately 85 per cent., when heated through 15 degrees will take up

$$1 \times 15 \times 0.075 \times 0.238 = 0.268 \textit{ B.t.u.}$$

The removal of 424,000 B.t.u. per hour is equivalent to removing 7066 B.t.u. per minute. Dividing this latter quantity by 0.268, 26,366 cubic feet per minute is obtained as the quantity of air entering the room. By referrring to the chart and following out the course of the dotted lines, it may be found that approximately 2.92 tons of refrigeration are required for cooling the air and 5.66 tons for condensing the vapor, for each 1000 cubic feet of air supplied per minute. The required refrigerating capacity is, therefore,

$$8.58 \times 26.36 = 226 \textit{ tons}$$

Increasing this amount by 2½ per cent. gives a capacity slightly in excess of 230 tons, which is somewhat below the figure previously obtained. This is due to the fact that in the chart the weight of the dry air in a cubic foot of a mixture of air and moisture is taken as 0.07 pound, whereas the actual weight of this air, under the conditions of the problem, is 0.075 pound. This is equivalent to a difference of 7 per cent., which is, approximately, the percentage difference in the refrigerating capacities as determined by the two methods previously given in this article.

In conclusion, the writer will mention certain features of interest in connection with a few of the more important air-cooling installations now in use in this country. One of the most notable is probably that of the New York Stock Exchange, which, at the time of its installation, was probably the largest air-cooling problem ever undertaken. The refrigerating plant comprises three units of 150 tons capacity each. The refrigerating capacity provided is such that a temperature of not over 75 degrees Fahrenheit and a relative humidity not to exceed 55 per cent., shall be maintained when the temperature of the outside air is 85 degrees Fahrenheit and the relative humidity 85 per cent. The refrigerating machines are of the absorption type and it is stated that they are operated by means of exhaust steam at a back pressure of some four pounds.

The Auditorium hotel, in Chicago, is equipped with an air-cooling system of considerable magnitude. The total space cooled is approximately 500,000 cubic feet and comprises the banquet hall, reception rooms, etc. An average difference of some 14 degrees is maintained between the temperature in these rooms and that of the office and main corridor during the summer season, while a difference of some 20 degrees is usually maintained during hot weather between the temperature within these rooms and the temperature of the outside air. The CO_2 system is employed—expansion of the gas occurring within the cooling coils. The CO_2 compressor is driven by an electric motor. It has been stated that the cost of operating this system is approximately $20 per day, which includes the cost of power, water and labor, but is exclusive of interest and depreciation.

The new Blackstone hotel, in Chicago, has an extensive air-cooling system which takes in the main restaurant, banquet hall, café, grill room and barber shop. Carbonic-acid gas is employed here also as the refrigerating agent, the gas expanding directly into the cooling coils. Water is sprayed over these coils by means of a small centrifugal pump, the water being cooled to about 45 to 50 degrees Fahrenheit in passing over the coils, while the gas within the coils is usually expanded at a temperature of about 20 degrees Fahrenheit. The outside air in being drawn through this cold spray and through the cooling coils experiences a drop in temperature of some 16 or 20 degrees, and leaves the cooling chamber in a saturated condition, thoroughly washed and at a temperature ranging from about 60 to 65 degrees Fahrenheit. Three separate cooling chambers have been provided, each having its own blower and connections by means of ducts with the room or rooms which it serves to cool. The blowers are of the double-intake type and maintain a pressure of from three-quarters to one ounce. The ducts are made of sheet metal and are provided with 1-inch asbestos air-cell covering. The air enters the room through ornamental registers located at a distance of some 8 feet from the floor, while the exhaust is taken from both the floor and the ceiling in order to promote the circulation of the air. Rheostats automatically regulate both the supply and the exhaust. It is claimed that within the rooms which are equipped with this system the average temperature during extremely warm weather is maintained at least 20 degrees below the temperature of the outside air.

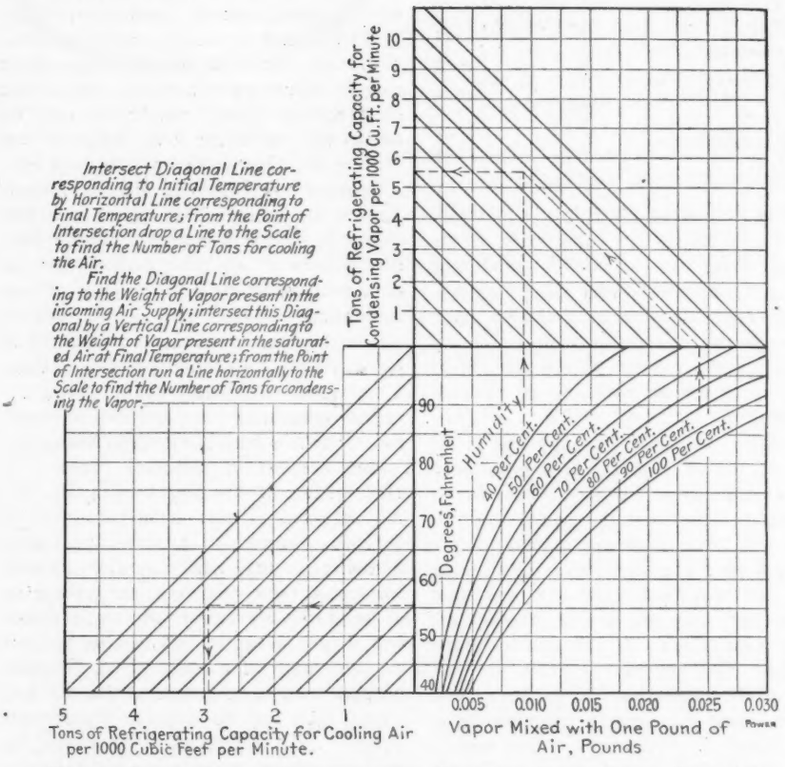

Intersect Diagonal Line corresponding to Initial Temperature by Horizontal Line corresponding to Final Temperature; from the Point of Intersection drop a Line to the Scale to find the Number of Tons for cooling the Air.
Find the Diagonal Line corresponding to the Weight of Vapor present in the incoming Air Supply; intersect this Diagonal by a Vertical Line corresponding to the Weight of Vapor present in the saturated Air at Final Temperature; from the Point of Intersection run a Line horizontally to the Scale to find the Number of Tons for condensing the Vapor.
Tons of Refrigerating Capacity for Condensing Vapor per 1000 Cu. Ft. per Minute
10 9 8 7 6 5 4 3 2 1
Humidity
40 Per Cent.
50 Per Cent.
60 Per Cent.
70 Per Cent.
80 Per Cent.
90 Per Cent.
100 Per Cent.
Degrees, Fahrenheit
90 80 70 60 50 40
5 4 3 2 1
Tons of Refrigerating Capacity for Cooling Air per 1000 Cubic Feet per Minute.
0.005 0.010 0.015 0.020 0.025 0.030
Vapor Mixed with One Pound of Air, Pounds
Power

FIG. 2. CHART GIVING REFRIGERATING CAPACITY REQUIRED TO COOL AIR

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POWER

Power Plant Belting

In the calculation of belting problems there is little occasion for the use of elaborate and perplexing formulas which serve no useful purpose, but rather mystify and puzzle those whose familiarity with algebraic expressions is limited. In the solution of belting problems, good judgment and mechanical common sense are the only mental requirements. Some knowledge or experience with surface friction is valuable but not a necessity.

In the installation of a belt-driven system, good mechanical judgment and common sense on the part of the engineer are of prime necessity, and each case should be decided on its individual requirements.

Probably one of the chief difficulties in the way of understanding belt problems is a lack of knowledge of the relation which belts and pulleys bear to each other. It is generally supposed that the diameter of the pulley over which the belt runs determines its load-carrying capacity. But, as a matter of fact, it is the linear velocity of the belt and it makes no difference whether it runs over a large or a small pulley; the tension being the same the power transmitted will be proportional to the speed.

Power is transmitted from a belt through pulleys by virtue of the friction existing between the surfaces. This friction depends on the tension and the speed at which the belt travels, and is not directly effected by the pulley diameter. A belt passing over a pulley at a given rate of speed and tension will transmit a certain amount of power, and while the speed and tension remain constant, changes in pulley diameters will not make any change in the power transmitted.

Doubling the diameter of a pulley doubles the surface contact, but with the tension unchanged there will be but one-half the pressure per unit of surface that there was and the frictional resistance will remain the same.

Changes in pulley sizes have been made to increase the driving capacities of belts which have resulted satisfactorily, because, with the change of pulley diameters there came an increase in the speed of the belt, and this instead of the increased surface contact, was the cause of the increased transmission.

As a brick will offer the same resistance to sliding, whether standing on end or lying on the side, so will a pulley of a given width offer the same frictional resistance to a belt, whether of one diameter or another.

It seldom happens that both pulleys in a belt transmission are of the same diameter, and the arc of contact varies, and the frictional resistance is proportional to the pressure per square inch and the pulley surface covered, and the longer the arc of contact the greater will be the area subject to the phessure. This being true, only the smaller of any pair of pulleys in a transmission need be considered, for on this pulley the arc of contact and consequently the total pressure will be least. It is just as though when the brick was turned on its end its weight was diminished in proportion to the reduction in its frictional surface.

The power which a belt will transmit is the product of the tension and the speed, and the power that may be taken is proportional to the arc of contact, being greatest for 180 degrees. For an arc of contact of 90 degrees the power transmitted is about 60 per cent. of that at 180 degrees and will increase with the number of degrees embraced, not because of the increased surface, but because of the increased pressure per square inch between the belt and the pulley as the surface embraced approaches 180 degrees.

Hard and fast rules for belt capacities are not possible, and there is probably more variation in the published formulas of different authorities than for any other power-plant equipment. This may have arisen from the fact that the difference between the load that a belt may be made to carry temporarily, and what it should carry, is so great that different factors of transmission are used by authors with varying conceptions of what constitutes best practice.

Among the many rational rules for leather belting, probably the simplest is that which says a single belt one inch wide traveling 800 feet per minute will transmit one horsepower. A double belt at the same speed will do 50 per cent. more. This rule contemplates a tension of about 40 and 60 pounds respectively for each inch of belt width.

It is somewhat approximated in another which allows 70 and 45 square feet of belt surface per minute per horsepower for single and doublt belts respectively.

Either of these rules, if followed, will provide ample reserve capacity and insure that the work will be done without undue stress.

Efficiency in belting consists in getting the largest number of horsepower-hours transmitted for the money invested. In some cases this may dictate a low-priced, inferior and short-lived belt, carrying a heavy overload with temporary construction. In others it means the best product the market can supply, moderately loaded and having a great reserve capacity for temporary overloads or future increase in requirements, and all phases of the problem should be fully considered when making an investment in belting.

Steam Consumption Guarantees

It is the practice for steam-engine builders to include in their proposals a statement of the amount of dry steam in pounds at the required pressure which the engine will use per indicated horsepower-hour. This statement is often made, whether called for by the purchaser's specifications or not, in the hope that the prospective purchaser will be influenced by the claim of a low steam consumption. Naturally the tendency is to make this steam-consumption guarantee as favorable as possible and such claims are based upon the most favorable conditions. Without actually realizing it, the builder sometimes makes his claims border on the extravagant and gives such figures as are seldom realized in actual practice.

In many cases these extravagant claims will not often favorably influence the well informed purchaser. Rather will he be inclined to seriously doubt them, and therefore weigh such a proposal but lightly, if the figures are less than may be shown by actual tests of similar engines working under similar conditions. Reliable figures of this sort are not always available.

However, the performances which may be expected from the different types of engines are fairly well known. Whenever, then, a proposal is received containing a guarantee of steam consumption which is less than might be reasonably expected under actual working conditions, and which the builder is not prepared to substantiate by actual and reliable tests, the purchaser has every reason to doubt the figures, and the result is likely to be unfavorable to the bidder.

It is really better, therefore, for the engine builder in such instances to use figures which he can substantiate and to rest his case, should others make more favorable claims, upon his reputation for reliability, the successful operation of his engine, and its proved economy.

The Wage Question

There is something wrong when a man who must spend years of time and study in his effort to become a master of his vocation is paid less per hour for the work of his hand and brain than one who, without mental attainments above those of the common laborer, may master all of the intricacies of the art of bricklaying in three weeks.

If a young man desires to become an engineer, he finds himself at the very outset handicapped by educational requirements that are met in few other callings.

At the bottom of the ladder, in the fire room, he finds that he must understand the elements of chemistry to burn coal intelligently. He may become an expert in the art of making clear, hot and smokeless fires, but without some knowledge of chemistry the why of his success or failure is a sealed book.

While the bricklayer is well paid for training a few muscles in a single direction, the engineer must train every faculty, for there are few arts or sciences that do not in some form find an expression in the daily round of a real engineer's duty.

In some States and municipalities he is required to demonstrate that he has had, not only the practical experience necessary to enable him to safely operate all types of power-plant apparatus, and has in addition sufficient technical training to calculate its probable or possible performance under all conditions of service.

To do this, requires more than ordinary mental attainments, more than common mechanical ability and a fertility of resource beyond that of the followers of any other calling. When the reward for the service of such men is compared or contrasted with that of the men in lines of useful work where mastership in both theory and practice may be had in a few months, the conclusion must be that intelligent, brainy, alert and conscientious men are at a discount as operating engineers.

There is something wrong, but what? What is the negative factor that fixes the average engineer's hourly wage below that of the digger of ditches, the hod carrier and the truck driver?

There has been a great change for the better since the days when the barber competed with the doctor for the neighborhood tooth pulling; but the advance in dental science has not exceeded that in steam engineering. The dentist is a professional worker and the barber from whom he evolved is nonprofessional, but both are better paid than the engineer whose work is as necessary to society and is as truly professional as that of the dentist. Is it because the engineer is not unionized? Is it because he is not more particular about his personal appearance? Is it because the employer does not appreciate the value of his service and regards his work as one of the many expenses of the business that must be kept at the lowest possible point?

Education was the foundation on which the largest engineers' organization in the world was built. Did the founders of this great body reason from false premises when they adopted the motto "To EARN MORE, LEARN MORE"?

Engineering Mathematics

It is surprising how many practical men are unable to successfully apply mathematics to the solution of simple engineering problems. These men often possess more than ordinary intelligence and in the pursuit of their vocations show a high degree of resourcefulness; yet when confronted with a mathematical application they are apparently helpless.

Just why this is true may at first seem hard to explain; undoubtedly there are several contributory causes; but one of the main reasons will be found in the manner in which mathematics is usually taught. Figuratively speaking, mathematical expressions are the tools for use in the solution of certain problems and they have a definite physical application. Without a knowledge of this application, they are analogous to a set of machinists' tools, each a fine instrument in itself but utterly useless when placed in the hands of one who is ignorant of the purposes for which they are intended.

Mathematics is usually classified as either pure or applied, the former dealing with the abstract and the latter with the concrete objects. The value of pure mathematics as a means of mental training cannot be denied, but very little of this as taught in the technical schools is used directly in later engineering practice. Instead, it is the applied mathematics that is constantly used, which, for the most part, involves a thorough grounding in arithmetic, and merely the fundamentals of algebra, geometry and trigonometry. In fact, very few engineering problems can be solved without a knowledge of one or more of these branches.

The practical man often finds, when attempting to study the subject by himself, that many of the books are not intelligible to him. This is because most of the books upon the subject are written as textbooks with a view to being supplemented in the class room by the explanations of the instructor. Unfortunately, however, too often the latter are not best adapted to bring out the application of the principles involved, and confusion results.

Taught with the aid of simple, everyday illustrations, such mathematics as are used in the majority of engineering problems could be grasped with very little effort.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Homemade Glass Float Needle Valves

The sulphate of aluminum solution used for the coagulation of river water before it passes through the sedimentation basins and filters, attacks brass and copper very readily, and one of the most annoying and frequently occurring petty repairs about our waterworks plant has been the renewals of the brass float valve, copper float and the brass discharge valve of the orifice box with which

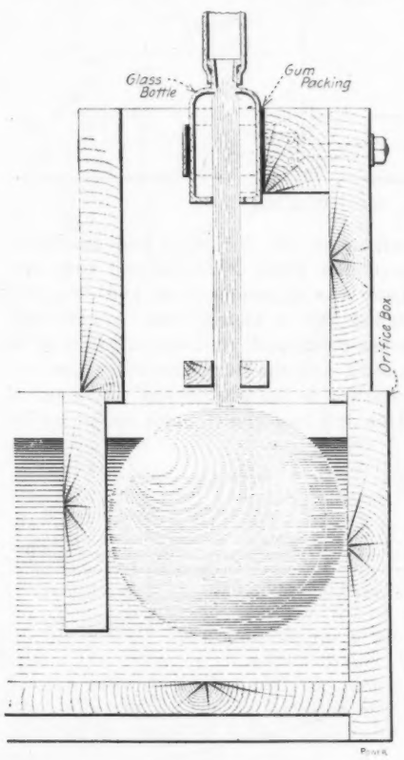


FIG. 1. SHOWING GLASS FLOAT VALVE

the filter plant was equipped by the builders.

After a few years of this annoyance it was determined to remedy this in some way. A hard-rubber float valve would have cost $35, and not caring to spend that much money it was decided to replace all of the brass and copper valves and floats about the orifice box with homemade glass ones.

For the float-valve stem a $\frac{13}{16}$-inch hole was ground in the center of the bottom of an ordinary 4-ounce acid bottle, using a piece of brass pipe and flour of carborundum for the grinding, the bottle being held in a wooden frame with guide pieces to hold the revolving pipe central with the axis of the bottle. A second hole $\frac{3}{8}$ inch in diameter was bored by the side of the first hole for the passage of the sulphate solution into the orifice box after it had passed the valve opening in the neck of the bottle, the larger hole being used merely as a guide for the $\frac{3}{4}$-inch glass rod which was ground into the neck of the bottle with a short bevel and which acted as the shutoff valve.

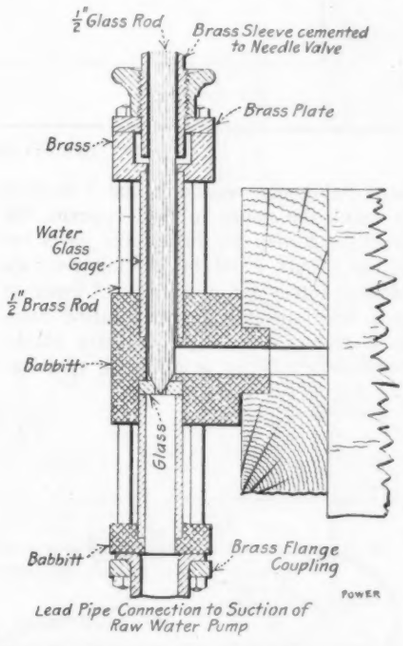


FIG. 2. NEEDLE VALVE IN ORIFICE BOX

An ordinary spherical glass float about 7 inches in diameter, such as is sometimes found in flush tanks, was used. The 4-ounce bottle was clamped to the side of a wooden box which was placed over one end of the orifice box and a guide was placed in the orifice box to keep the float central with the glass rod. The top of the bottle was then connected with the lead pipe from the solution tank, using a short piece of 1-inch light rubber tubing for that purpose and the trick was done. The whole thing cost $1.50 and the time spent in making it was very little. Fig. 1 shows the float valve in section.

The device which was gotten up for a needle valve for regulating the discharge of sulphate solution from the orifice box is shown in section in Fig. 2. It is made out of a block of babbitt metal, two pieces of $\frac{3}{4}$-inch glass water-gage tubing, a $\frac{1}{2}$-inch glass rod and a small square of plate glass having a tapering hole in the center, the whole being bolted together with four brass rods taken from an old water-column gage. The material

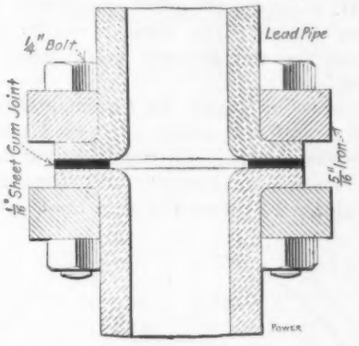


FIG. 3. SHOWING SPECIAL JOINT

did not cost as much as that for the float valve but it took longer to make on account of the machine work on the babbitt metal. This glass needle valve has the advantage over the brass devices ordinarily used in that the orifice will remain constant in size and will not increase in diameter from the action of the solution on the metal.

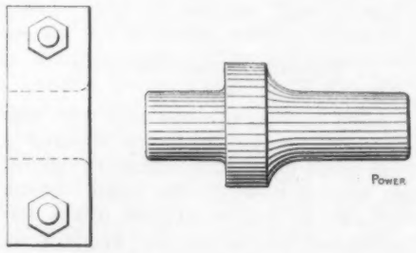


FIG. 4. TOOL FOR FORMING FLANGE OF JOINT

The brass unions used in connecting the lead pipe about the sulphate-solution tanks were also in need of constant renewals, so the joint illustrated in Fig. 3 was designed, the flanges being made of $\frac{5}{16}$ boiler plate bored out with a fillet to fit the pipe, and the flange turned on the lead pipe by means of the tool shown in

Fig. 4. The lead pipe was coupled to the angle valve on the solution tank by means of the same kind of flange joint, using U-shaped bolts around the body of the valve for bringing the flange of the lead pipe to a joint against it.

There is a yellow deposit which accumulates in all pipes carrying sulphate of aluminum solution that makes it necessary to take them apart occasionally for cleaning. This frequent handling and the consequent and unavoidable binding of the lead pipe cause it to increase in length and to make bad connections. This tendency was obviated by putting the lead pipes through wrought-iron ones and making each length not more than 12 feet long.

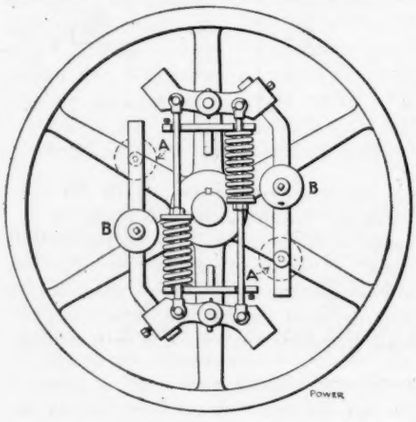
T. H. DESAUSSURE.

Milledgeville, Ga.

Adjusted the Governor

Some years ago I took charge of a small electric-light plant containing an Atlas engine. The man in charge reported that the governor was practically worthless.

I stood by during the first night's run and controlled the engine as best I could with the throttle. On the following day I examined the governor and found the weights set as shown at *A* in the sketch,



DETAILS OF THE GOVERNOR

and the springs adjusted to a high tension. These two conditions required a high speed to produce sufficient centrifugal force to overcome the tension of the springs. At a speed of from 325 to 350 revolutions per minute the weight arms were thrown out to the limit, thus practically closing the steam ports. The engine at once slowed down and when at a speed of about 250 revolutions per minute the springs would bring the weights back to their original position with a slam, and then the engine would race again.

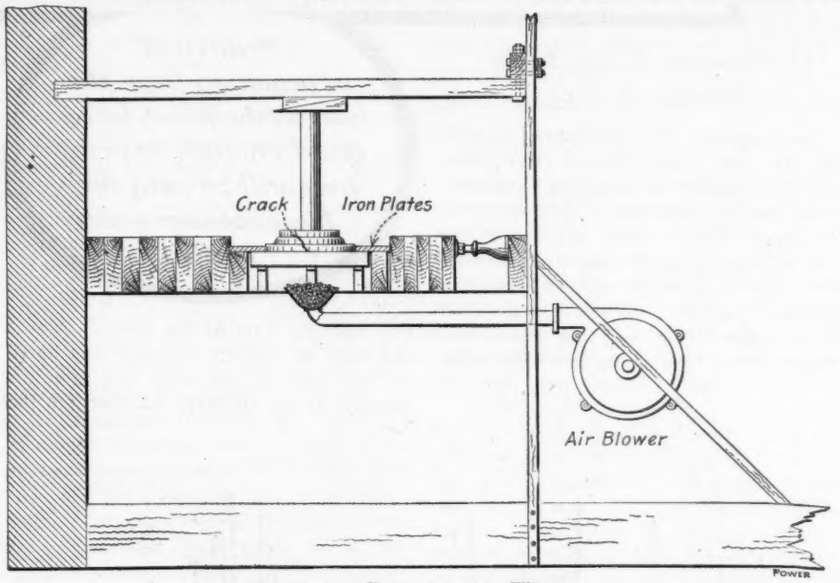
I moved the weights to the position shown at *B* and relieved the tension on the springs. These adjustments removed all governor trouble with the engine.

R. S. LIVINGSTON.

Deweyville, Tex.

Welding a Flange

Some time ago I discovered that the 5-inch suction flange on a duplex pump was cracked through on one side, and it was necessary to operate the pump as soon as possible. The space around the outside of the flange would not permit a band being put around it and I decided to break the flange in two, opposite the crack, and then try fusing the parts together. This I did by placing the two broken halves on a couple of irons to keep them level and then heating them to a fusing heat in an ordinary blacksmith forge. When at a fusing temperature I added a slow, steady pressure to the solid part of the flange, thus forcing the two broken parts together, as shown in the illustration. It has been in use for six months and has given entire satisfaction.



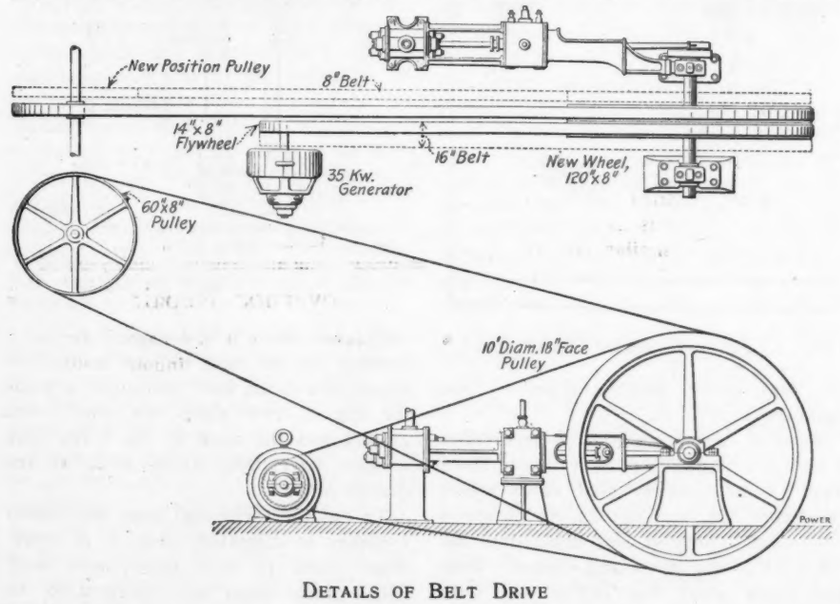
HOW THE FLANGE WAS WELDED

H. L. RUSSELL.

Keans Cañon, Ariz.

Interesting Belt Drive

The accompanying illustration shows a belt drive that was originally installed to run a boiler shop. A 14x30-inch Corliss engine drove an air compressor which was arranged tandem with it. The flywheel was divided and one 8-inch belt ran up to the line shaft and another 8-inch belt drove a 23-kilowatt generator. Later the demand for air and electricity called for a change and a two-stage, cross-compound air compressor was installed and the air compressor that was attached to the engine was disconnected. This left the engine with an underload and a 75-kilowatt generator was installed, in place of the small one. The driven pulley on the line shaft was moved and a new pulley was placed alongside of the flywheel, as shown by the dotted lines. The shop could not be shut down long enough to turn a single crown on the old flywheel, so the gen-



DETAILS OF BELT DRIVE

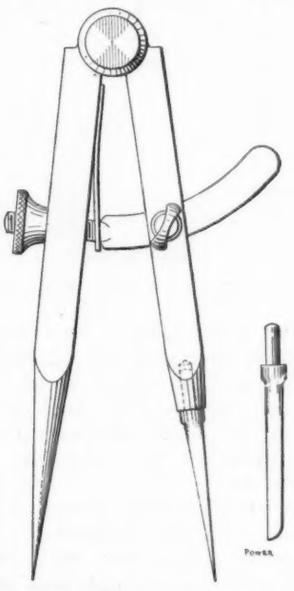
erator was ordered with a single high crown and a 16-inch double belt was put on. This has been running more than a year and has never given a moment's trouble. The change was made by moving the old generator close to the flywheel and shortening the belt. A foundation was built for the new machine where the old one formerly stood; and the new generator erected on it. The switchboard was also changed without breaking into the regular running hours of the shop.

E. W. ASHENDEN.

Minneapolis, Minn.

Gasket Cutter

In the illustration is shown a gasket cutter. It is made from a carpenters' divider by cutting off one leg and drilling in about ⅜ inch with a ⅛-inch drill. The cutter is made out of the tail end



HOMEMADE GASKET CUTTER

of a file and is fitted into the hole as shown. The cutter is then tempered.

I have used a similar tool for many years and would not be without it. A new cutter can be made in a few minutes if needed.

A. L. JOHNSON.

Somers, Mont.

Improving Efficiency of Air Pump

A wet-air pump connected to a surface condenser failed to produce a high vacuum in the condenser within a reasonable time when starting up, but the trouble was overcome as follows: A hole was drilled in the top of each suction pipe between the condenser and pump and tapped out for a ½-inch pipe. Jets were then made out of ½-inch pipe, as shown at *Z*.

The portion of the pipe below the thread *B* was turned down slightly smaller than the diameter of the bottom of the threads and staggered longitudinal slots were milled in the pipe to preserve its strength as much as possible.

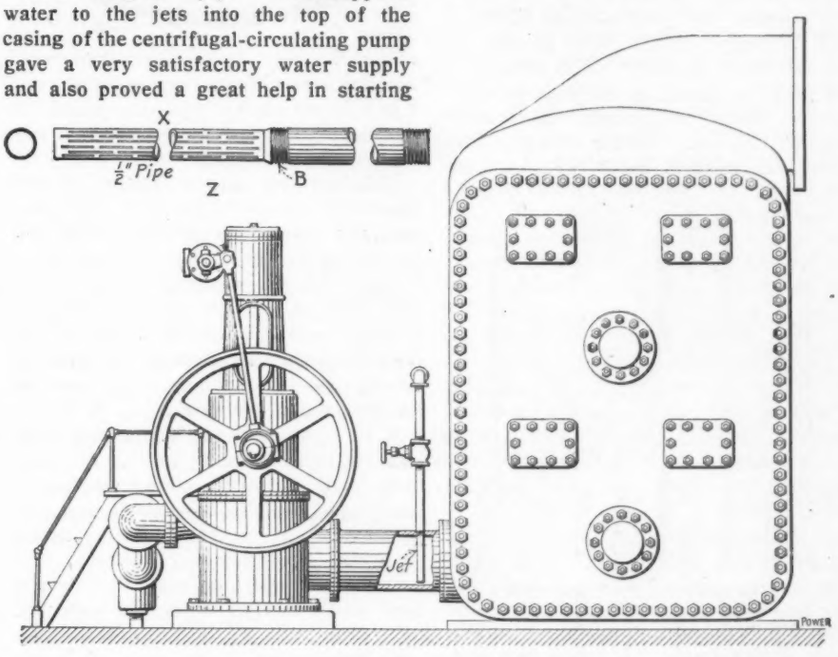
The slots were milled on but one side of the pipe and covered an angle of about 150 degrees, as illustrated by the drawing.

The distance *X* is slightly less than the diameter of the suction pipe.

The nipples were then screwed into the suction pipes with the jets facing the vacuum pump, as shown in the elevation, and connected to a suitable water supply.

A small quantity of water effectively sealed the pump valves and caused the vacuum to rise quickly in the condenser.

Connecting the pipe which supplied water to the jets into the top of the casing of the centrifugal-circulating pump gave a very satisfactory water supply and also proved a great help in starting



SPRAY NOZZLE IN SUCTION PIPE

the circulating water when the pump refused to pick it up.

G. B. KAMPS.

South Bend, Ind.

Governor Repair Job

In plants where it is necessary to keep all the engines in continuous operation from one week's end to the other, one is sometimes confronted with some very perplexing propositions. This is particularly true when it would be a matter of a week or more before the repair parts required could be obtained.

A few days ago the main eccentric strap on one of the engines broke without warning. The engine was making 210 revolutions per minute at the time, and the broken part of the strap went into the governor, breaking an auxiliary spring. The weights on both weight arms were smashed and moved out of place.

So far as the eccentric strap was concerned, I had an extra part on hand, but I had no extra auxiliary springs and as only 2 inches were broken off the end, I decided to give it a shorter bend in order to increase its length sufficiently to get a bearing on the finger extending through the fulcrum casting. This made it necessary to remove the good spring on the other side of the governor and bend it as near like the broken one as possible.

I found two weights belonging to another engine that were of the right diameter but much heavier than the ones smashed. They were drilled and tapped for setscrews, but I needed two more. A piece of 4 7/16-inch shafting was obtained and two more weights were made from it. By gathering up all the pieces of the broken weights I could find and weighing them I got an idea of the amount of weight required, and by adding enough of the smaller weights which were not broken to the homemade heavier ones, I was able to get within a few ounces of the desired weight. After placing these in position on the weight arms the engine was going again in about six hours.

In another instance I had trouble in holding the babbitt shoe on the bottom of an old-style crosshead. Brass shoes were made to take the place of the babbitt metal. It was necessary, however, to take the crosshead out and plane about ½ inch off each end in order to allow the brass shoe to fit up over the ends and afford means of fastening them by cap screws, as the crosshead traveled very close to the ends of the guides and the original length had to be maintained to prevent striking at their end against the guide blocks. These brass shoes have been running several months with scarcely any signs of wear and with absolutely no trouble.

THOMAS M. STERLING.

Middlebranch, O.

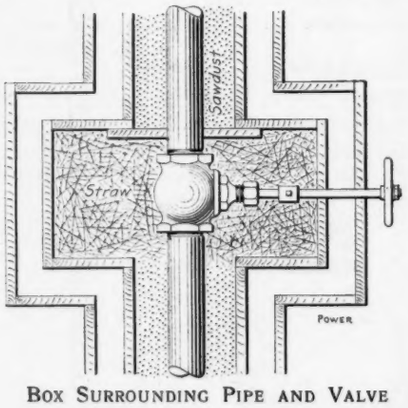
Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Prevent Standpipe Freezing

In reply to the question asked by a correspondent, in the September 12 issue, how to prevent a standpipe from freezing, I submit a description of a job used where the temperature is sometimes 25 degrees below zero. It has been in use for years and has never had a "freeze up."

The water pipe is 3 inches in diameter, and the water in it is often at rest for several hours at a time. The pipe is in a double box having an air space between the two boxes, which were made out of 1¼-inch lumber. No tar or other material was used to make the joints air



BOX SURROUNDING PIPE AND VALVE

tight, although care was taken to make neatly fitting joints. The box is under cover and rain cannot get at it. If it is to be placed where rain or snow would strike it, a couple of coats of liquid tar or other weather-resisting material would be necessary on the outside of the large box.

The space between the outside of the pipe and the inside of the sawdust box is 4 inches. The air space between the two boxes is 3 inches. The valve box is made with a larger space and is tightly packed with straw. A board prevents the sawdust from falling from the upper part of the pipe box to the valve box. The valve handle is extended so as to come outside of the box, as shown. The covers are attached with screws.

J. E. NOBLE.

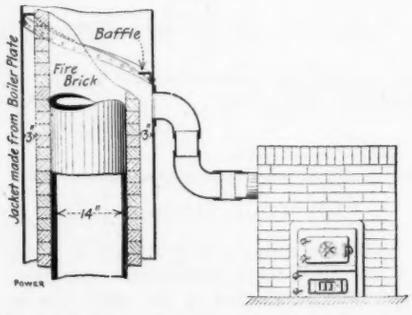
Toronto, Can.

Thomas Nicholson's query under the above caption in the September 12 issue recalls to mind an experience related to me several years ago by an engineer who had had a similar trouble.

His plant was situated in northern Russia and the object, during the major part of the year, was not so much to prevent the water from freezing as to keep it in a liquid state at all. The standpipe was not so long as Mr. Nicholson's, being but 28 feet high.

This engineer was in charge of the plant at the time the standpipe and storage tank were installed, and he had the 14-inch pipe, which was constructed of riveted-steel plates, carefully built around with firebrick and fire-resisting cement. A jacket made out of the sheets of discarded boilers was erected around this, leaving a 3-inch annular space between the jacket and the brick.

A small brick stove for burning coke was put in at the base of this arrangement. The cost of the coke used figured very small on the cost sheet and the standpipe was successfully protected from the effects of the cold. The coke fire was kept going at night and during light loads and prevented the water in



PROTECTING A STANDPIPE FROM FREEZING

the tank at the top of the pipe from freezing when the demand was light, as the heated water in rising in the pipe displaced the cold water in the tank above.

I might suggest that baffles riveted to the jacket might have helped to distribute and get more effect out of the heat. They may be arranged as shown in the sketch herewith, which shows the idea.

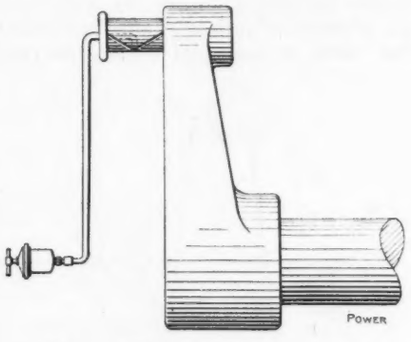
JOHN S. LEESE.

Manchester, England.

Crank Pin Oiler

Daniel Ashworth's crank-pin oiler, which was described in the issue of October 3, is a very good one to use where the speed of the engine is uniform and high enough to keep the oil traveling toward the pin.

The high- and low-pressure crank pins of a large Corliss engine driving a two-



GREASE CUP CRANK-PIN OILER

stage air compressor, were equipped with similar oilers and they worked very well while the compressor was working at its full capacity and speed, on the day shift, but during the night, the air demand being low, the air governor kept the speed down very low; consequently the pins would not get proper lubrication and would run dangerously hot.

The oil cup and pipe down to the union were removed and a large grease cup was put on, as shown in the accompanying illustration, which overcame the heating at low speeds.

FRED L. WAGNER.

Chicago, Ill.

Questions for Discussion

Replying to Mr. Rockwell's inquiries in the September 12 issue, I would suggest in answer to question No. 1 that he heat a piece of pipe red hot on one end and put the hot end in cold water; he will then get some idea of what occurs when water is put into a red-hot boiler. The water will enter the pipe and there will be a rush of steam from the cold end, caused by the rapid expansion.

Regarding question No. 3, which relates to a condensing engine being suddenly relieved of its load and attaining a dangerous speed with the throttle closed tight, and the condenser running, if Mr. Rockwell has an engine which will per-

form this stunt he should feel like patting himself on the back and saying, "Big discovery, old man," for all plant owners are studying economy and this looks like a great coal-saving scheme.

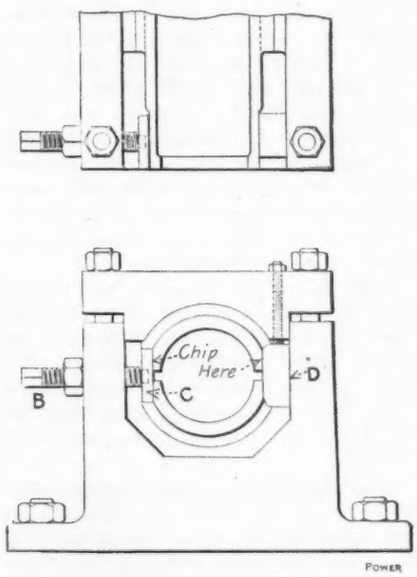
C. M. THOMPSON.

Hurricane Isle, Me.

Poorly Designed Bearings

The October 10 issue of POWER contains an article on poorly designed bearings.

I formerly had a small fan engine, the flywheel of which vibrated in the manner shown on page 559.



FAN ENGINE BEARING

When an engine having this type of bearing is new, no trouble of this kind will be noticed, but if the cap which holds the shells in place becomes a little loose, the shells will work back and forth in a horizontal plane and some become so worn that no amount of tightening will stop the vibration.

The bearings should be put in good shape with enough liners removed so that there is about 0.008 inch clearance between the top shell and the shaft. A piece of soft-lead wire laid on top of the shaft before the top shell is replaced and the cap pulled down solid will do. If the cap and shell are then removed the thickness of the wire will show the clearance.

The side of the shell in front of the joint should then be chipped off flat, so as to get a fairly good full bearing horizontally for the plug *C*, shown in the illustration, and equal to the full vertical diameter of the setscrew *B*.

Two holes should then be drilled and tapped to receive the setscrews, care being taken that the holes do not weaken the pillow-block casting. The setscrews should be about the same diameter as the studs which hold the cap down, and the end turned or ground off down to the bottom of the threads. The end should fit rather loosely in the hole in the plug so as to allow the plug to cant slightly in case there are imperfections in the chipping. The setscrews with their jamb nuts should then be screwed in and the plugs put on their ends and set up until they just touch the shells.

The cap should then be replaced and screwed down tight. If the nuts are marked where they came on the studs when they were keyed and the lead taken, they should be turned to these marks and no farther or a hot box will result.

After the engine is started and carrying its load, the setscrews should be set up a little at a time, so as not to push the shells out of line. This should be continued until they are solid and the wheel stops wabbling.

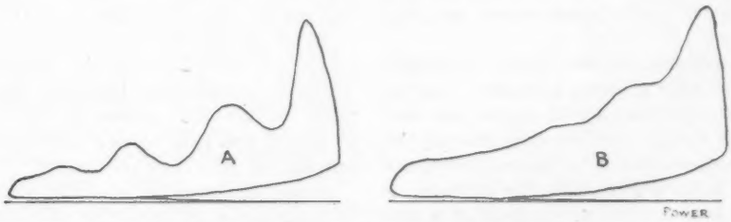
If there is not enough stock in the pillow-block casting to permit drilling, two steel blocks should be made and fitted as shown in the back of the shaft at *D*. These blocks should be made with a taper of about ⅛ inch to the inch. Two holes must be drilled in the cap, and tapped for setscrews, which may be as small as ½ inch in diameter. After the cap is replaced and the engine carrying its load, the setscrews are set down, pushing the tapered blocks down and wedging the shells. If one side starts to warm up, slack the setscrew a little and take up on the other side.

CHARLES BENNETT.

Chicago, Ill.

Vibration of the Indicator Pencil

J. W. Taylor, in the October 31 issue of POWER, has a very interesting article on "Vibration of the Indicator Pencil."



DIAGRAMS FROM SAME GASOLENE ENGINE

While Mr. Taylor's explanation of the "jagged expansion line" is in the main correct, there are certain minor respects in which his reasoning is at fault and which might lead a good many into error.

In speaking of the rapidity of vibration he says: "The arm is the only part of the indicator subject to vibration which has anywhere near this frequency." Again, "The frequency of vibration depends upon the length and section of the arm and the weight of the pencil holder." From these statements one might infer that the arm is subject to elastic vibrations within itself similar to the vibrations of a tuning fork.

Now, a piece of tempered steel proportioned and loaded like an indicator arm will have a period of elastic vibration of more than 1000 beats per second. Moreover, a deflection of $\frac{9}{64}$ inch, if considered an elastic deformation of the arm, would mean a fiber stress of several times the breaking point of the best tempered steel. The important point which seems to have been overlooked is that the vibration in question is one of the indicator spring itself together with all the moving parts attached to it.

The statement is also made that "The vibrations of the arm are set in motion by a sharp blow produced by a rapid change of pressure." It is not a rapid change of pressure which causes shock, as witnessed by the absence of vibration in the compression line; in fact, there may be no shock at all other than that due to play in the pencil motion. The vibrations are set in motion by the inertia of the indicator parts which at any sharp corner in the true outline of the indicator diagram are unable to change their state of rest or motion instantly, so that in this case the pencil first lingers above the true expansion curve, and then gaining downward velocity, passes below it, the vibration gradually dying out because of friction in the indicator piston, etc.

I have indicated steam engines which gave the type of diagram under discussion and have had more interesting experiences with the gas-engine indicator in which the fundamental causes of vibration are more accentuated by the sharp point which occurs at the top of the ignition line. At high speeds this effect becomes quite prominent and the two accompanying indicator diagrams bear witness to the fact that the indicator piston is a part of the vibrating system together with the pencil motion and a piece of lead on the pencil point if it is desired to put it there. These two diagrams were both taken from the same gasolene engine running at 500 revolutions per minute, the engine carrying approximately the same load. The same indicator was used but was furnished with two sizes of piston, the smaller of which was one-fourth the area of the larger. There were two springs, one registering 160 pounds per inch in hight. This spring with the large piston was used to obtain the diagram *B*, showing

the smaller wave effect. The other spring was of 60 pounds capacity and if used with the quarter-size piston would give a 240-pound pressure scale. It chanced, however, that the small piston was heavier than the large one. The result, as shown by the indicator diagram *A*, as would be naturally expected, was that the heavy weight attached to the light spring vibrated more slowly and with a greater amplitude from the same provocation than did the light weight attached to the stiff spring.

AMOS F. MOYER.

Buffalo, N. Y.

Engine Knocks

I have had the same experience with engine knocks as cited by W. A. Mills. I found that the clearance of the piston was not even at both ends, there being but ⅛-inch clearance at the head end cold; when heated up, a slight amount of moisture in the clearance at the head end caused a knock. A loose-fitting piston or exhaust valve will also cause a knock when steam is admitted.

WILLIAM NOTTBERG.

Kansas City, Mo.

Value of Engine Room Inspection

I was very much interested in Mr. Collins' article, "Value of Engine Room Inspection," in the October 24 issue of POWER. A number of years ago, when I was running a small plant, I would go over everything to see if the man I relieved was trying to "put" anything over on me and also to see how much I could find in order to "knock" on him. During the past 10 years, however, I have been going over everything daily, but with a different object in view, the successful handling of the load as it came on. It is impossible to always leave everything in first-class shape, but the relief should always be told what is wrong or likely to be.

For instance, if No. 1 main bearing is running a little warm, tell him, or, better still, always have a pad on the desk and put the thing down so that he can see, and then you are sure that you have told him. It matters not if No. 2 guide is hot, if No. 3 condenser is dirty, if a tube has just been lost in No. 28 boiler and the man in the coal tower has a motor that sparks badly and needs an electrician for a few minutes. If you give your relief warning he will get out of it all right. If you do not, the chances are he may have trouble and the comeback will be bad for you.

It has been the custom in my experience for the water tenders and oilers to change shifts about half an hour ahead of the engineers; then they have time to make an inspection and report to the engineer; thus if anything is wrong, both the engineers know it at the same time. The man you are relieving wants to know these things, and he will not leave you to get out of the trouble as best you can.

There are always a few things I want to do when I enter the engine room, as find the temperature of the condensers, how far the valves are open which supply the circulating water, so that I may know what we have to go on each unit. Next come the feed pumps and the quality of coal. I also find out if there is any extra load, due to a breakdown in some other plant. This is important to the water tender for a stoker cannot be rushed like hand firing.

If oil is burned, see that there is plenty in the supply tank. It is good practice to find out if there is any trash in the river, or whether much slush ice is coming down, for there is nothing that will put a plant down and out, especially if there are two or three turbines, as trouble with the condensers.

K. C. JONES.

Reno, Nev.

Important Engine Tests

Referring to Charles Thomas' article in the October 17 issue, page 595, on the subject of testing engines for leakage, I do not wish to be understood as criticizing any of the excellent methods he recommends, but it occurs to me that in case one wished to look into the subject further, he would have to ask himself the question, If the piston shows steam tight on either dead center, is that a guarantee that it is the same at all other points of the stroke?

In reboring large cylinders and in calipering others to see whether they were worn materially, I have noticed that they show the greatest wear at or near the middle of the stroke. While the steam ring would, if in good condition, adjust itself to this enlargement of the bore, it stands to reason that the leakage will be in proportion to the wear.

To get around this question, many able engineers and erectors for the engine builders recommend blocking the flywheel at different points of the stroke of piston, and then testing with steam as outlined in Mr. Thomas' article.

It has occurred to me that a supply of compressed air might be of service to test out an engine cylinder and valves. I have sometimes used it to test the tightness of a globe or gate valve, and have found that when a valve holds compressed air well, it is not going to leak steam to any extent. Has any reader of POWER ever tried this, and if so, with what results?

As air does not condense, like steam, one could pump up a tank of air, and having ascertained that there were no leaks from the tank or the line, close the engine-throttle valve and connect the air to the steam chest and to each end of the cylinder in turn. The speed with which the air pump had to run, or the rapidity with which the pressure in the tank went to zero, would be an indication of the tightness of the parts in question.

I think the above would give a closer approximation of leakage than in laying out the theoretical curve in the expansion line of an indicator diagram, as described and recommended by numerous textbooks.

L. F. BROWN.

Winston-Salem, N. C.

Engineers' Reference Book

I am using an engineering reference book having every feature mentioned by Phil Lighte in the October 17 number.

About four years ago I started to develop an engineering reference book which would not be too large for the pocket, and would allow the removal and addition of pages with ease. I first bought a so called ring binder with ¼-inch rings and a 3x5-inch page bound on the side. I soon found this would not do as the pages wore rapidly in the rings so that they would come out and I had a really "loose" leaf book.

The one I am using at the present time takes a 4x7-inch sheet bound on the end with a soft-brass rod that holds the pages firmly without any wear. It is made by Asa L. Shipman's Sons, of New York, and is known as their No. 300 binder. It has a capacity of about 1 inch of paper.

The paper I use is called glazed onion skin; it comes in 8½x11-inch sheets and any printer will cut it to fit the book for a nominal charge. This paper is very strong, will stand hard service, is not easily soiled and 500 sheets occupy a space of only ⅝ of an inch. At first I wrote on the pages with pen and ink and found that wherever the fingers touched the paper the ink would blur; at the present time all the pages are written on a typewriter.

In arranging the pages in the book different subjects may be grouped so that additions may be made without disturbing the arrangement. For instance, boilers, page 200, dimensions of a return-tubular setting, page 210, heating surface of return-tubular boilers with different tube spacings; any additional pages on dimensions can be added and numbers given up to 209; then a letter should be added as 208A or 209B. In this way an index can be arranged which will not have to be changed much as the additions are made.

Some of the subjects covered in my book are, areas of circles, alloys, belt formulas, beams, boilers, coal analysis, combustion, condensers, chemicals, columns, controllers, conduit-wiring data, and all the way down the line to water, weight of, at various temperatures, wind pressure, wrenches, etc.

A little careful thought in arranging the index will make it easy to find any-

thing wanted; for instance, under C, Conduit-wiring data and under W, Wiring data, conduit.

This book can be easily carried in the hip pocket and when you want to settle an argument it is handy to have the "dope."

I have often thought that some arrangement could be made with the large advertisers to issue sheets of this kind and use the margin or back of the paper for their advertisement.

R. J. RIVERS.

Minneapolis, Minn.

In POWER of October 17, Phil Lighte asks for a few ideas on the above subject. The result of some years of experience is offered herewith.

A properly kept engineers' notebook soon becomes an exceedingly useful tool and the time devoted to it will bear good interest. As the result of his own and others' mistakes, the writer's experience is that the notebook should be of the loose-leaf variety. Do not use staples or other fastening devices for holding any kind of sheets together, in connection with some stiff paper cover or "common-sense" binder. This may do for things of odd size, for photos, blueprints, etc., but for a notebook it takes too much time to fit in or remove sheets. Procure a standard loose-leaf binder, with a good leather cover, preferably flexible; front and back united. Select a binder with rings, as the book will lie open perfectly flat, a feature possible only with ring books. If the binder is not crowded with too many sheets, has a strong card front and back and is handled with care, it will give satisfaction.

Sheets 6x9 inches are best because this is the size of most publications, and often one desires to insert valuable tables from these papers or from catalogs. Likewise, there appear full-page diagrams in such 9x12-inch periodicals as POWER, *American Machinist,* which, if folded once, and the bottom margin sheared off, can readily be inserted in the notebook. For one's own charts or drawings and tabular matter a 6x9-inch page seems small enough when a fair-sized volume is expected. The writer has in use one loose-leaf book containing 2 inches of sheets, but prefers his books having 1-inch rings, supposed to hold 100 sheets; half-inch rings would be too small. Loose-leaf manufacturers make binders up to 3¾x6¾ inches in size with six rings, and the larger sizes with but three rings. They also usually omit to provide an envelop or pocket for holding indicator diagrams, personal cards, stamps, etc.

To carry the book in the pocket, 6x9 inches will be too large, unless one is satisfied to carry in a 4x10 envelop only a group of the sheets temporarily removed from the binder. The 6x9-inch binders are not listed in the "I — P" series, but come under the name of Walker's book. Cooke & Cobb Company, Brooklyn, N. Y., are the only makers of this size I know of.

The paper should be white, of good quality, strong yet thin, and preferably without a watermark, which shows when the sheets are blueprinted. Quadrille ruling of faint tint, with squares $\frac{1}{32}$ to $\frac{1}{16}$ inch are most convenient for technical work, writing on each line, on one side of the paper only. For legibility, all notes should be written with either waterproof india ink or with Higgins' eternal ink, which is sufficiently black to yield good blueprints and yet liquid enough to flow in a fountain pen. It is a good plan to put aside a blueprint of each sheet, so that a loss of the book would not be felt too keenly. The paper ought to be smooth and tested as to whether it takes the pen readily, as rough paper may be good for lead pencil only.

After experimenting with numerical indices, the alphabetical index was found to be simpler, quicker and more economical in space. A set of guide sheets, leather tabbed, from A to Z, can be had with the binder.

In the arrangement of contents, one must adopt a plan of his own, as strict rules will not be followed. One man is thinking of "engines, steam," the other of "steam engines"; the first puts his notes on a sheet back of letter E, the second writes under S. When taking notes of steam, gas and oil engines it is preferred to keep them separately under S, G and O. When in doubt as to whether data on air compressors belong under A or C, simply turn to either and see how it was done before. Maintain the same location and soon the place adopted will be fixed in the memory. Do not attempt to follow within a 1-inch book the elaborate subdividing of subjects practised in large libraries, for it is wasteful in space and time. There are not likely to be more than two dozen sheets under S, and as these are page numbered consecutively S1, S2, or S1.1, S1.2, or S1a, S2a, etc., so as to assist in maintaining their chronological order, and as the various headings are neatly underlined, any particular memoranda can be found quickly. A brief cross reference, such as "see S18," on page S3, for instance, connects new notes with older ones on the same subject. This will avoid using a lot of sheets with only a few lines written on each. It is only necessary to place the matter where it naturally would be diverted by a keyword if one had been assigned.

As to the importance of dating, men will preserve a clipping from some publication but neglect to write on it the name and full date; draftsmen will prepare plans and leave off the date; others merely state the month and day, not the year. Always indicate the source of the information and the date somewhere on every sheet.

Some employers object to having any record of experience, observations, practice, tests or prices in private custody, or they will claim ownership to the book and all its contents, even to items foreign to their business, if they have been entered during working hours. The employer had best be asked at the outset what his pleasure would be if it should ever come to a severing of connections; each man must decide for himself. For a private book one should not appropriate binders and paper not personally paid for. The owner's name and address should appear in front of the book.

Do not use a loose-leaf book as a receptacle for old letters, sketches, etc., converting it into a wallet. Use a letter-filing case, as otherwise the note sheets will be forced off the rings. Keep only a few blank sheets in reserve in the back, and preserve the stock of clean sheets elsewhere until required.

Once the excellent habit of taking notes has been acquired, one book will soon be filled up, when a second one of exactly the same size can be started, either distributing the one alphabet over the two books, or, what is usually better, keep in the one book all matter which is referred to most frequently, or which logically belongs together.

CHARLES H. HERTER.

New York City.

Using the Firm's Stationery

In the October 24 issue, Paul Montague writes of an engineer's discouraging experience in using the firm's stationery when writing for catalogs, adding that he has often wondered how many catalogs never come and how many manufacturers miss sales to the engineers who use the firm's stationery.

Unless otherwise stated in the letter, the advertisers will usually send their catalogs and literature to the address on the letterhead. Nearly all the catalogs which come to the firm's office which do not directly interest are dumped into the waste basket and the engineer never gets them. I have found this out through personal experience when going to the office and seeing a catalog in the waste basket which I had written for on the firm's stationery.

I still use the firm's letterhead in writing for catalogs and information from advertisers, for it gives a letter an air of responsibility and the advertiser will quote prices more readily than if the letter were written on plain paper. I always state my position and whether I have the authority to buy, and to address me personally.

Since adopting this method of writing, I usually get very courteous treatment from advertisers.

M. W. UTZ.

Minster, O.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Length of Belt

The distance between two pulley centers is 30 feet. One is 18 feet and the other 18 inches in diameter; how may the length of the belt be found?

R. F. H.

Subtract the radius of the smaller pulley from the radius of the larger and divide the difference by the distance between the shaft centers.

In a table of sines find the angle whose sine corresponds to the above quotient; call this angle *A*. Divide this angle by 90 and call this result *B*.

To result *B* add 1 and multiply the sum by the radius of the larger pulley and by 3.1416. Call this product I.

Subtract *B* from 1 and multiply the remainder by the radius of the smaller pulley and by 3.1416. Call this product II.

Multiply the distance between the shaft centers by 2 and by the cosine of the angle *A*. Call this product III.

Add products I, II and III together and the sum will be the length of the belt. Applying this rule will give 95.56 as the length of the belt required to fit the conditions of the problem. The formula for the correct length of a belt is

$$L = \pi R\left(1 + \frac{a}{90}\right) + \pi r\left(1 - \frac{a}{90}\right) + 2d\cos. a$$

in which

R = Radius of the larger pulley;
r = Radius of the smaller pulley;
d = Distance between the centers of the pulleys;
a = Angle whose sine is $\frac{R - r}{d}$.

Tables of sines and cosines are contained in all engineers' reference books.

Delivered Power, Line Resistance and Current

Knowing the power delivered at the end of a line, the resistance of the line and the voltage at the *generator* end, can I calculate the line current and the drop?

G. A. H.

You can if you have the patience. The process is as follows:

Divide the square of the generator voltage by four times the square of the line resistance; divide the delivered power by the line resistance and subtract the quotient from the first quotient of squares; take the square root of the result and subtract that from the quotient of generator voltage divided by twice the line resistance. The final result will be the line current. Written as a formula:

$$\frac{Volts}{2 \times Res.} - \sqrt{\left(\frac{Volts}{2 \times Res.}\right)^2 - \frac{Watts}{Res.}} = Current$$

In this formula,

Volts = Generator voltage;
Res. = Line resistance;
Watts = Delivered power.

Example:

Generator voltage = 500
Line resistance = ½ ohm
Delivered power = 23,750 watts

$$Current = \frac{500}{1} - \sqrt{\left(\frac{500}{1}\right)^2 - \frac{23{,}750}{0.5}} = 50$$

Multiply line current by line resistance to get the drop.

Heat Units in Coal and Natural Gas

How are the B.t.u. in coal, natural gas and other fuels found?

H. L. S.

The number of B.t.u. per pound of coal or other fuel is found by burning a known weight of the fuel to be tested in a calorimeter. The heat generated is absorbed by a known weight of water, the rise in temperature of which is a measure of the heat generated. Such calorimeters were described in POWER for September, 1905, and the articles have been reprinted in a book entitled "Engine Room Chemistry," by Dr. Augustus H. Gill.

The heat value can be computed if a chemical analysis of the coal is available as follows:

Divide the fraction of one pound which consists of oxygen by 8 and subtract the quotient from the fraction of a pound which consists of hydrogen. Multiply the difference by 4.28 and add to the product the fraction of a pound which consists of carbon. Multiply the sum by 14,500 and the product will be the number of B.t.u. in a pound of the fuel.

Cause of Water Hammer

What is water hammer and its probable cause?

E. L. L.

It is caused by a plug of water getting into rapid movement in the pipe and bringing up against a dead end, a tee or elbow, or something which suddenly arrests its motion. If a plug forms so as to cut off the steam on the far side of it, the steam on that side will condense, making a vacuum or reduced pressure on one end, while the boiler pressure is on the other, so that the plug gets into very rapid motion and the hammering effect is often sufficient to rupture a fitting.

Filling Pits in Commutator Bars

The commutator of a 300-kilowatt generator has a small pit between the commutator bars. How may it be satisfactorily filled?

C. D. B.

A common practice is to fill such a pit with a paste made of plaster of paris and pure orange shellac. If the pit is deep, fill it nearly to the surface with dry plaster of paris and apply the paste on top. A better filler is made of powdered asbestos, mixed with silicate of soda or water glass to the consistency of a stiff paste.

Heating Surface of Corrugated Flue

How is the heating surface of a corrugated flue calculated?

H. S. C.

To find the surface of a corrugated flue multiply the average diameter, that is, one-half the sum of the larger and smaller diameters, by the length and by 4.93, all dimensions to be in feet. The heating surface will be that portion of the flue above the level of the grates.

Fire Extinguisher Formula

Please give me a formula for a good and cheap liquid fire extinguisher.

H. S. R.

There are a great many formulas for making liquid fire extinguishers. One which is perhaps as good and as cheap as any other consists of 2 pounds of common salt, 10 pounds of chloride of ammonia and 6 pounds of water. This is thoroughly mixed and sealed in thin bottles, to be thrown into the base of the fire.

Fatal Boiler Tube Blowout

On November 16, at 3 a.m., in a dredge used on the barge-canal construction near Cayuga, N. Y., one of the tubes of a 400-horsepower boiler burst, scalding to death four men by the escaping steam. The dredge was equipped with two boilers of the same size and kind, Babcock & Wilcox marine type, the one which failed being located on the starboard side. They had been running continuously night and day and under full evaporation, at the time of the accident. A new shift had gone on duty, consisting of two firemen, Edward Whitlock and James Dalton, of Seneca Falls. According to the reports of the survivors of the crew of the dredge, everything had been going smoothly, when, without warning, one of the tubes of the starboard boiler gave way just as Dalton was in the act of firing. The outrushing steam blew the coal bed into the boiler room, knocking down Dalton and covering him with ashes and live coal. There was no time for Whitlock to escape as the boiler room was instantly flooded with steam. The room was at the time tightly closed on account of the severity of the weather. The two other men who were killed were Norwegian employees of the dredge contractor's company, who had stepped into the boiler room only a few minutes before to get from its warmth a brief respite from the weather. The engineer, operator and oiler, who were elsewhere engaged on the dredge, were not injured, nor was any further damage done.

The Seneca Falls coroner conducted a preliminary investigation into the causes of the accident the morning it occurred, after which the contracting company adopted the policy of refusing outsiders the privilege of examining the ruptured boiler. Before this time, however, it had been seen by the reporter of a local newspaper and by numerous employees of the company. From these the following facts have been received and authenticated:

The tube which burst was one at the end of the lowest row. The fracture was as shown by Fig. 1, and was on the under side of the tube about 6 inches from the bridgewall. The longitudinal fracture was about 6 inches long, and the transverse about 4 inches long. Another tube at a point near the fracture appeared to be slightly blistered.

The boilers had been in use three years. They operated at 175 pounds gage, and the pop safety valve was set to blow at 200 pounds. The feed water was drawn from the Seneca river, which is somewhat muddy and contains a small amount of lime. A filtration system was used to keep the make-up and the return from the condensers clean.

The boilers were overhauled by the company the latter part of last September and part of the brick setting around the furnace of the starboard boiler replaced. They were passed upon by an insurance-company inspector a few weeks later. The story is current that one of the inspectors made an examination only of the port boiler, the one which did not fail. There was a fire in the starboard boiler at the time so he merely "looked it over" and passed them both on the assumption that if one was all right, the other, being just like it, was in equally good condition.

Employees of the company say that for some time past the boilers were forced. It is fairly well established that some of the tubes leaked. A neighboring resident told the writer that the fireman, Whitlock, declared a short time ago he would give up his job "next week"—he was afraid of the leaky tubes. It was admitted by the foreman of the section of the barge canal where the dredge was in operation that there were leaky tubes. "But," he said, "the leaky tubes were in the port boiler."

In analyzing the cause of the accident, one is first struck by the peculiar nature of the fracture shown in Fig. 1. If it had been caused by overheating it would

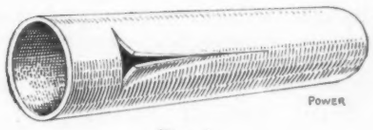


FIG. 1.

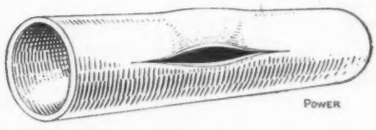


FIG. 2.

very likely have been like Fig. 2. A transverse fracture, if secondary in sequence to a longitudinal one, would be expected to be at the middle of the first one, since there the maximum bending occurs to cause a cross tearing. That the transverse opening is at one end of the longitudinal suggests that it occurred first, the force of the outpouring steam then tearing the metal lengthwise from this slit. This would indicate either defective material or an overstrain produced mechanically.

The possible causes are:

First. Defective material in boiler tube.

Second. Material weakened by pitting or corrosion.

Third. Material weakened by overheating due to low water or forcing.

The first cause seems likely from the character of the fracture. On the other hand, the boilers were worked three years, so that any inherent defect of material would have probably shown before. The reputation of the boiler manufacturers, also, is against this theory. But, of course, defective material may appear in the best of products.

The effect of possible contaminated feed water can be ascertained only after examination of the ruptured boiler. In view of the recent overhauling and care in filtering the feed water, this explanation seems unlikely. The peculiar transverse break in the tube, however, may be due to some such cause.

It was said that the water column showed normal level at the time of the accident. This may have been and yet, of course, there may have existed low water in the boiler. A change of shift makes this possibility more likely. The boiler that gave way was in parallel with the port boiler at the time; if overheating due to low water caused the break, then the port boiler furnished the steam that did the damage. Nothing can be concluded as to this without examination of the broken tube. Forcing the boilers continuously, combined with some scale, may have caused the blowout. The boilers were undoubtedly forced, but, again, the effect can only be judged after physical examination.

The coroner's inquest, which will probably take place within a week, will undoubtedly bring some light upon the causes of the accident.

An instance of pathetic heroism was shown by the fireman, Whitlock. He recovered sufficiently to regain his feet. When the doctor from Cayuga attempted to benefit him, he was met with the words, "I'm too far gone—do what you can for the others." All four sufferers died within four hours, despite help.

Large Hydroelectric Power Project in Northern California

The Northern California Power Company, of San Francisco, has inaugurated one of the largest electrical enterprises yet attempted in California on the "Big Bend" of the Pitt river, in Shasta county. The project has been contemplated since September, 1902, when the original notice of an appropriation of 250,000 miner's inches of water was filed by the company. With definite plans formulated and surveys completed, articles have been recorded specifying a change in diversion of the water as first made to a point about 1½ miles further down the stream, thus affording the development of maximum power afforded.

A dam will be constructed across the river at this point 120 feet long and 7 feet above the low-water level. By such impounding the flow will be diverted into ditches and tunnels for a total distance of 5¾ miles to about 1 mile below the Big Bend hot springs, where the power plant is to be located. It is estimated that there will be 4 miles of open ditch, the remainder of the distance to comprise five tunnels, the longest being 6000 feet. These latter will be 24 feet wide by ap

proximately 26 feet high, thus permitting the boring to be executed by steam shovels, and offering a distinct departure from usual practice. At the outlet the fall of the water will be close to 15 feet, with a width of 32 feet and 50 feet at bottom and top respectively.

The power plant will have a total generating capacity of about 90,000 kilowatts, and with its diversion dam, pipe lines and flumes will represent an investment of $4,000,000. The power developed will be transmitted in three circuits on steel towers, traversing the entire northern section of the State, and tying in the plant with the company's other generating stations. The transmission system is estimated to cost $10,000 per mile.

Power for construction purposes will be delivered from the company's Kilarc power house and all machinery and supplies will be hauled by team from Redding by way of Ingot and Montgomery creek, a distance of nearly 70 miles. Manager E. V. D. Johnson estimates that it will require two years to complete the entire project.

Municipal Plant Makes Money

Morrisville, Vt., a town of 2700 inhabitants, owns an electric plant which is run at a profit, and is offering power to the local industries at $20 a horsepower per year.

More than 20 years ago, according to the daily press, municipal ownership was obtained by the purchase of a small private water system, and the authorities were soon able to reduce the price of water and raise the standard of service. In 1895 a municipal lighting plant was installed and the water system was extended. The plant cost about $25,000, which, added to the indebtedness incurred for the water system, made the total $58,000. This was continued until 1906, the income from the plants paying the interest, repairs and upkeep.

Anticipating future needs, the commissioners bought part of the power rights of a manufacturing plant at Cady's falls and a concrete dam 1100 feet above the old dam was constructed which increased the head from 17 to 40 feet. The new structure was 330 feet long, 20 feet wide, had a shore line of five miles and developed several hundred horsepower.

Approximately, the dam and its equipment cost $70,000, making the cost of the two systems $168,559.82.

The plant furnishes electrical energy for 8000 incandescent lamps and power is supplied to many small manufacturing plants. The authorities have contracted to furnish power to the Waterbury & Stowe electric-railroad company at half the cost that company hitherto paid.

Morrisville offers free sites and exempts from taxation those industries which will find the town suited to their needs.

Annual Meeting of Mechanical Engineers

The annual meeting of the American Society of Mechanical Engineers will be held as usual in the Engineering Societies building, New York City, from December 5 to 8.

Some noteworthy papers have been secured by the committee on meetings, and an important feature this year will be contributions by three of the first subcommittees appointed by the committee on meetings, those on textiles, cement manufacture and machine-shop practice. One session is to be devoted to foundry practice, another to steam-boiler performance. The gas-power section will as usual have a session, at which oil engines, at present a subject of so much importance, will be discussed.

The program of entertainment, as arranged by the committee on meetings, contains many interesting features, among which will be an inspection of the SS. "Olympic," visits to the Navy Yard, Bush Terminal buildings and other points of interest.

Semi Annual Meeting of Ohio Engineers

The Ohio Society of Mechanical, Electrical and Steam Engineers held its twenty-fourth meeting and celebrated the tenth anniversary of its organization at Canton, O., the city of its birth, on November 17 and 18. The meeting was well attended and full of interest.

Only two formal papers were presented, one upon "Superheated Steam," by Prof. E. A. Hitchcock, of the Ohio State University, and one upon "The Fusing Temperature of Coal Ash in Its Relation to Rate of Combustion," by E. G. Bailey, mechanical engineer of the Fuel Testing Company, of Boston, Mass. Mr. Bailey's paper appears on pages 802 to 806 of the present issue and that of Professor Hitchcock's will follow shortly.

Visits were made to the Dueber-Hampden Watch Company and to the Forest stations of the Electric Light and Railway Company. The officers elected for the following year are: President, E. M. Adams, Akron; vice-president, Prof. E. A. Hitchcock, Columbus; managers, for three years, James H. McConnaughy, Warren; W. F. Hubbell, Wauseon; manager for one year, to fill the vacancy caused by the election of Mr. Adams as president, William C. McCracken, Columbus. The next meeting will be held at Pittsburg, Penn., on May 16, 17 and 18. The society has maintained its membership of some 270, notwithstanding the vigorous scaling down of the delinquent list.

OBITUARY

George W. Hebard, acting vice-president of the Westinghouse Electric and Manufacturing Company, died at his home in New York City on Friday, November 17. Mr. Hebard was born in Barre Center, Olean county, New York, in 1845, and was, therefore, 66 years of age. He had been in poor health for some time previous to his death.

Besides his active participation in his chosen profession, Mr. Hebard was also very active in social, religious and philanthropic work in New York. He was a member of the Union League, The Lawyers, The Engineers and several other clubs.

Mr. Hebard leaves, residing in New York, a wife and two children; Charles

GEORGE W. HEBARD

R., engaged in the cotton business; Arthur, engaged in the ammunition business, in which his father was engaged prior to entering the electrical profession.

Mr. Hebard was sole executor of the Marcellus Hartley estate, which owned the Union Metallic Cartridge Company and the Remington Arms Company; all of which he settled in a most satisfactory manner to all concerned.

He was identified with the early history of the manufacture of electrical apparatus, becoming president of the United States Electric Lighting Company, of Newark, in 1882, and had associated with him, as directors, Marcellus Hartley, Anson Phelps Stokes, Charles R. Flint, Henry B. Hyde, Charles F. Brooker, Leonard Curtis, and other well known men. Mr. Hebard was connected with the early history of the generation and distribution of electric lighting in New

York City as a director and stockholder of the United States Illuminating Company. In this position he had to do with the equipment of the Weston lighting system on Brooklyn Bridge, parts of which are still in service. Later, as president of the United Electric Light and Power Company, he was closely affiliated with the introduction of the Westinghouse alternating-current system in New York City by means of the overhead system. He was active later on in the change of the distribution system from the overhead to underground. At the time the United States company was taken over by the Westinghouse company, Mr. Hebard was president, and in the reorganization was made vice-president of the Westinghouse company; and, in 1888, when this company took over the Sawyer-Man company, Mr. Hebard was given charge of the newly acquired organization.

The death of Mr. Hebard is the third one to occur in the last few months among the higher officials of the Westinghouse Electric and Manufacturing Company residing in New York; the others being Edward St. John, treasurer, and Robert Mather, chairman of the board of directors.

PERSONAL

Howard B. Clark, consulting engineer, of New York City, resigned as member of the firm of Flaherty & Clark on June 1 and is now Eastern representative for the McNaull-Boiler Manufacturing Company, of Toledo, O., a manufacturer of water-tube boilers.

Jacques Abady, a director of the English firm of Alexander Wright & Co., Ltd., engineers and manufacturers of measurement and control apparatus, sailed for London via Quebec, on November 17, after a two weeks' visit to Alexander Wright & Co.'s American branch, the Precision Instrument Company, of Detroit. Mr. Abady is one of the co-inventors of the Simmance-Abady combustion recorder, Simmance-Abady vacuum and pressure gages and other apparatus for testing various conditions of steam, gas, water and air. His visit was partly with the object of discussing several new inventions, which have passed the experimental stage and which will shortly be on the market for general use in steam and gas plants.

Bruce W. Benedict, for several years in the motive-power department of the Atchison, Topeka & Santa Fé Railway, has been appointed director of the shop laboratories in the department of mechanical engineering at the University of Illinois. Mr. Benedict was graduated from the University of Nebraska with the class of 1901. He served an apprenticeship on the Chicago, Burlington & Quincy Railroad prior to entering college, and after graduating he occupied successively on the same railroad the following positions: machinist, assistant in testing laboratory, assistant road foreman of engines, road foreman of engines, general foreman of locomotive and car repair, and mechanical inspector. He left the Chicago, Burlington & Quincy Railroad Company to become an editor of the *Railway Master Mechanic*, of Chicago, a position which he held for two years. Leaving Chicago, he became supervisor of schedules on the Atchison, Topeka & Santa Fé Railway, and still later bonus supervisor on the same road, which position he will give up before the first of the year to assume the duties at the University of Illinois.

NEW PUBLICATIONS

RAILWAY SHOP KINKS. Compiled by Roy V. Wright. Published by *Railway Age-Gazette*, New York. Two hundred and ninety pages, 9x12 inches; 803 illustrations. Price, $2.

This work was compiled under the direction of a committee of the International Railway General Foremen's Association from the pages of the *Railway Age-Gazette* and contains descriptions of a large number of shop kinks or methods of doing many kinds of locomotive- and car-repair work in railway-repair shops in all parts of North America.

The work is profusely illustrated with both line cuts and halftones, is completely indexed and contains a wealth of valuable information for the practical railway mechanic.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES FOR BUYERS AND SELLERS; twentieth annual edition. Published by Samuel E. Hendricks Company, New York City. Price, express charges prepaid, $10.

The 1911 edition of the widely known "Register" contains over 350,000 names and addresses and upward of 45,000 business classifications, and is indispensable as a buyers' reference for architects, engineers, contractors, manufacturers, jobbers, retailers, exporters, purchasing agents and for railroads, machine shops, foundries, mills, factories, mines and also for mailing purposes.

An important change has been made in the system of indexing the contents. In the previous editions the numbers following the classifications referred the inquirer to the page number on which the article was classified, while the system adopted for indexing the contents of this edition is so numbered that they refer direct to the classification; consequently the page numbers have no connection with the numbers used in the index of contents. This system greatly simplifies the location of the manufacturers of any article listed in the book.

It contains 1420 pages and is substantially bound.

The Bureau of Mines, at Washington, D. C., announces the following new publications: Bulletin 13. A résumé of producer-gas investigations, by R. H. Fernald and C. D. Smith; 378 pages, 12 plates. Miners' Circular 5. Electrical accidents in mines; their prevention and treatment, by H. H. Clark. The reprints are: Bulletin 24. Binders for coal briquets, by J. E. Mills; 56 pages. Reprint of United States Geological Survey Bulletin 343. Copies will not be sent to persons who received Bulletin 343. Bulletin 28. Experimental work conducted in the chemical laboratory of the United States fuel-testing plant, St. Louis, Mo., January 1, 1905, to July 31, 1906. Reprint of United States Geological Survey Bulletin 323. Copies will not be sent to persons who received Bulletin 323. Bulletin 27. Tests of coal and briquets as fuel for house-heating boilers, by D. T. Randall; 45 pages, 3 plates. Reprint of United States Geological Survey Bulletin 366. Copies will not be sent to persons who received Bulletin 366. Bulletin 35. The utilization of fuel in locomotive practice, by W. F. M. Goss; 28 pages. Reprint of United States Geological Survey Bulletin 402. Copies will not be sent to persons who received Bulletin 402.

The Bureau of Mines has copies of these publications for free distribution, but cannot give more than one copy of the same bulletin to one person. Requests for all papers cannot be granted without satisfactory reason. In asking for publications they should be ordered by number and title, and all applications should be addressed to the director of the Bureau of Mines, Washington, D. C.

In a carefully prepared and tastefully gotten up booklet entitled "The Whole Kewanee Family," the National Tube Company, of Pittsburg, Penn., has included all the "Kewanee" specialties manufactured at its Kewanee works.

As a constant reminder of their call and of the Kewanee union, the company's specialty agents, when visiting the engineers and other consumers, are leaving a handsome nickeled "life-size" union in paper-weight form.

While the paper weight has been sent on written request from members attending the National Association of Stationary Engineers' convention, it is intended that the paper weight will act as a reminder when the company's agents are calling on the trade, and is not for general distribution.

The book department of the Engineering News Publishing Company has been purchased by the McGraw-Hill Book Company, 239 West Thirty-ninth street, New York. This adds to the list of the McGraw-Hill Book Company a considerable number of important standard treatises, primarily in the field of civil engineering. The transfer of this business was made on November 6.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

On August 1, James Schermerhorn, publisher of the *Detroit Times*, stepped forward upon the platform at Ford Hall, Boston, and delivered a memorable address.

He spoke for the doctrine of truth in advertising.

The occasion was the seventh annual convention of the Associated Advertising Clubs of America.

Three thousand advertising men cheered his effort and echoed his sentiment.

To that part of the public which has always read advertisements with the tongue in the cheek, that speech and that convention would have been a revelation. For advertising's representative men put themselves squarely on record as believers in these fundamental facts—in all the world there is no more potent argument for a good article than the truth about it, and it doesn't pay to advertise a poor article.

That's a combination of ethics and business that protects the buyer anyway it is read.

In part, Mr. Schermerhorn said:

"I believe this is the place and time to come with a plea for an ethical test of advertising. Splendidly your president has sought for the past two years to give the advertising craft the dignity and tone of a profession. If you are to become a profession, you must here and now formulate a code. That code need but spell one word, truth, and all other worthy things shall be added unto you.

"It is a fitting place to thus exalt your calling. Truth took entire charge of Boston's earliest advertising. There was no benzoate of buncombe in the copy from Concord and Lexington, from Bunker Hill and the Boston Tea Party.

"The advertising author ought to aspire to truth, not only for truth's sake, but because something of the soul of the artist and poet should be in his work. The advertiser is really the literary exponent of an age of commercial romance, when the fairy fables of Galland and Grimm are being outdone in the astonishing achievements of the business world.

"So the advertiser must be true to his task—as true as the historians, dramatists and poets who have embalmed the very mood and temper of their times in imperishable literature.

"China is wiping out the opium habit by stopping the cultivation of the poppy. You can correct dishonest advertising by cutting off the copy.

"Could anything be more simple? Truth stands at the door and knocks. Truth has tried other doors. Opportunity may knock but once, but Truth can show you a severe case of abrasion of the knuckles.

"She has bade the subscriber let her in; but the reader is generally unresponsive. He possesses all the widely heralded instrumentalities for getting what he wants—initiative, referendum and recall—but he tries none of these progressive weapons upon the newspaper that betrays his confidence and profanes his home.

"Truth has pounded upon the prosperous publisher's door, but the impatient rap has been drowned in the roar of the octuples.

"Some publishers whose presses do not run so long and so hard have heard the knock.

"Why not give the place of your present deliberations a new renown through the deliverance of advertising from dishonor, and impart to Faneuil Hall, consecrated shelter of free speech and unfettered trade, the later glory of being the cradle of an emancipated press?"

The day is not far distant when advertising will shake off finally and for all time the burden of bunk it has had to bear.

It will be the work of a trinity—the honest advertiser, the courageous publisher and a discerning public.

There is but a modicum of fake machinery advertising. Aside from all things else, the initial investment is too great to warrant building poor machinery in the hope that its sale can be forced through sky-rocket advertising and selling methods.

In the next place no reputable publisher will permit the advertising section to be encumbered with fake ads if he knows it.

Thus the Selling Section, containing the announcements of reputable manufacturers who court the fullest publicity, is a safe and sure guide for every buyer of power-plant machinery and supplies.